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Description of the
western Islands of Scotland
including the Isle of Man.

by

John Macculloch

In three vols.

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1819

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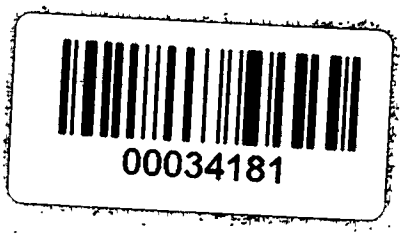

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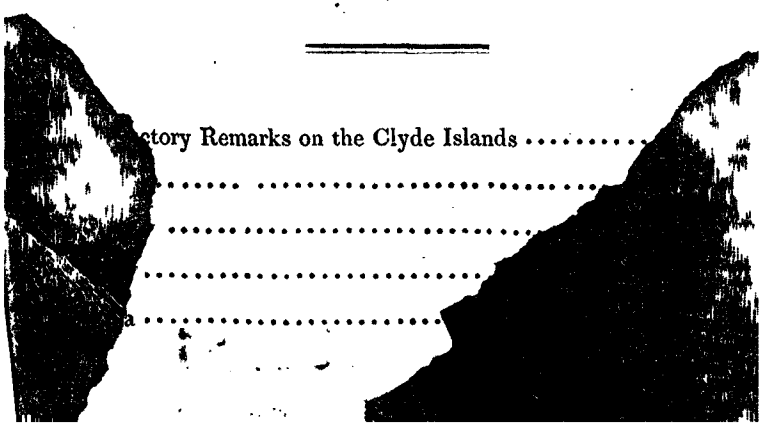

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OBSERVATIONS

ON

THE GEOLOGY

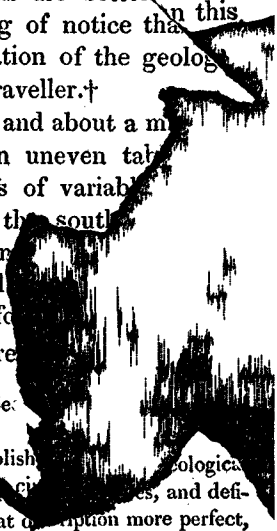
OF THE

WESTERN ISLES OF SCOTLAND.

STAFFA.*

FEW objects in the Western islands are better known, and few perhaps are more deserving of notice than this celebrated spot, no less the admiration of the geologist than of the painter and the general traveller.†

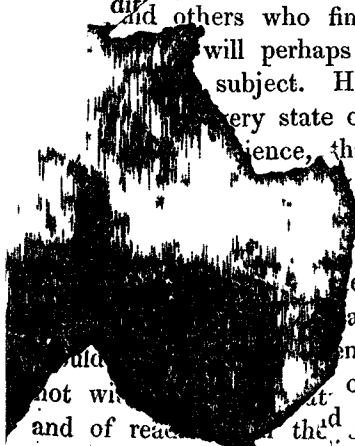
It is of an irregularly oval shape, and about a mile and a half in circumference, presenting an uneven table terminating nearly all round in cliffs of variable height. The greatest elevation lies toward the south, and appears, by my barometrical measurement, to be [illegible]. The surface is covered with a rich soil, [illegible] producing however but few plants [illegible] a botanist. I observed none which are [illegible]



* From Staf, a staff or pole; Swedish. Se[illegible] that of Mull. Also Plates VI. and VI[illegible]

† A slight sketch of Staffa was formerly [illegible]ublish[illegible] [illegible]ologica[illegible] Transactions, but imperfect in some essenti[illegible]ci[illegible]es, and deficient in others. In attempting to render that d[illegible]ription more perfect, and, in thus extending the history of this island, I have only to regret that I dare not illustrate it by engravings as finished and as numerous as it merits. The description will be much aided by the accompanying sketch of a plan made by pacing, with the aid of a pocket compass; unfortunately for its accuracy, in a gale of wind and rain. Although very incorrect, it will serve the present purpose of reference nearly as well as if it had been more perfectly measured.

these maritime coasts: and among them the mos[illegible]t attractive are Ligusticum scoticum, Rhodiola rosea, Matricaria maritima, and Rosa spinosissima. Staffa is pastured by a herd of black cattle, but there has long ceased to be a house on it; the change in the system of Highland farms having materially altered the distribution of the population over most parts of this country. The want of some shelter from an occasional storm has frequently proved a cause of inconvenience to the visitors who in summer time crowd to this far-named spot. It would become a serious evil, should a boat be detained for a night or more; a circumstance not unlikely to occur during the gales of wind which in autumn rise so suddenly on this coast.



Mu[illegible]culty being conceived to attend this expedit[illegible] which is commonly made a subject of very ground-[illegible] terror to persons inexperienced at sea, by the boatmen and others who find an interest in exciting alarm, the [illegible] will perhaps not be displeased to hear the truth [illegible] subject. Having visited it several times, and in [illegible]ery state of wind and weather, I am to say, [illegible]ience, that a landing may always be [illegible] in any weather in a boat of [illegible]ployed in visiting [illegible]uld keep the [illegible]t of Ulva. I have act both landed [illegible]en my long of eighteen feet [illegible]able to live sea which broke [illegible]n not a man on all the coast [illegible] I must add, that it was not wi[illegible] of p[illegible] whose want of knowledge and of rea[illegible] the delicate management required for a small boat in a difficult sea, are enough to fright even a bold seaman. The landing places lie to the eastward, and are therefore to the lee of those winds which in general, and particularly in summer, bring a heavy sea on them. A fresh breeze from the east or south-east will undoubtedly cause a swell on this shore; in which

case it would certainly be difficult, if not impossible, to land; but even with such winds a landing may still often be effected on the low rocks to the north-west. These winds are rare in summer, and still more rarely can they be attended with much swell; as the water has but a short run from the coast of Mull, and as such partial seas are soon quelled by the tide currents of these narrow straits. There are different creeks at the eastern and most frequented landing place, in one or other of which the washing of the swell round from the windward side may be avoided: in doubtful cases a prudent pilot will moor his boat astern first; by which means it may always be gently brought up to the rocks, and secured by one hawser, or by two carried to the opposite sides of the creek. By the same expedient an embarkation may also be safely effected.*

The landing being once made, the great cave† is accessible at all states of the tide except that of extreme high water with a heavy sea rolling into it; a circumstance

* To the few hints already suggested to those who may be inclined to make this interesting tour, I may add one respecting the best rigging for a boat in this squally climate. Those of the country are in general well adapted to the sea, from their buoyancy; being often of Norwegian construction, and bought from the fir-freighted vessels in their voyages southwards. They are rarely furnished with sails, and when that happens they are ill rigged, and further rendered extremely unsafe by the total ignorance of their management already noticed. The best sail is that known by the name of the shoulder-of-mutton, since it is both safe and easily managed. It carries no weight aloft and is particularly snug when reefed; is more easily shifted or taken in than the sprit or lug, without endangering the boat by suddenly altering its centre of gravity; is incapable of being taken aback, gibes without hazard, and enables a boat to carry more canvass than any other form. The fault of being occasionally becalmed in a heavy sea is well compensated by these advantages. Nothing but the difficulty of changing established habits, to which seamen are particularly attached, could have prevented its universal adoption instead of the inconvenient and dangerous lug-sail in such common use.‡

† Commonly known by the name of Fingal's cave.

‡ Plate XXX. fig. 5.

which can rarely happen to the tourist, since a boat will seldom be out in that sea which would render access to it impossible. But it can not be thoroughly seen unless entered in a boat, except by expert climbers; nor can the two caves situated at the south-west side be visited in any other manner, since they admit of no access from above. The visit to these two caves is, like that to the former, made an object of terror by the native boatmen; partly from a desire to avoid trouble, and partly from want of skill and knowledge of the ground. The Boat cave indeed cannot, on account of its very small size, be entered at all, except in calm weather and at high water, as its mouth is obstructed by rocks. In entering any of these caves it is necessary that the boatmen on each side should be provided with boat hooks or short poles; as, for want of room, the oars cannot be used in guarding against the surge which washes into them. These hints will not be misplaced if they save those who are desirous of a complete knowledge of Staffa, from the disappointment they must otherwise experience in consequence of the laziness and fraud of the boatmen who ply in the port of Ulva.*

* The hospitality and generosity of the Highlanders have long been celebrated. But this is, like Apelles, to paint Antigonus in profile only. The extortion practised by them on travellers has been a frequent subject of remark: in the hire of boats, it exceeds that of the men of Deal. It has not been the lot of Dr. Johnson alone in this country to observe, that "that honesty is not greater where elegance is less." This habitual extortion presents an amusing, but not an inexplicable contrast, to the hospitality which every one who has travelled in this country must also have experienced. The milk is given with the utmost generosity, but if purchased, even from the same individual, ten times the value is required. The unshod horse who has been chased over the mountain till he is wearied, and is brought in at two o'clock, with stirrups of rope and a halter for a bridle, must be hired for the remainder of that day at a price equal to that of an English hunter fresh for the morning field; often indeed, superior. That this disposition is frequently the simple result of avarice and fraud is undoubted. But in some cases it seems merely to arise out of the commercial spirit; overacting itself from

A considerable portion of the precipitous face of Staffa presents a columnar disposition. The highest point of this face lies between the great cave and the Boat cave, and is, by the plummet, 112 feet from the high water mark.* It becomes lower in proceeding towards the west, the height near Mackinnon's cave being only eighty-four feet. From this it extends with some variation to the north, where it subsides into a flat rocky shore elevated but a few feet above the sea. Here it again rises, and after continuing precipitous for a short space, declines into that irregular rocky shore on which the small beaches forming the landing-place are situated; whence it once more gradually rises, till, becoming again vertical beyond the crooked cave, it returns to the point from which we commenced.

But it is necessary to describe more particularly the details of the columnar forms, since in these consists the chief interest of this beautiful spot. The columns in the neighbourhood of the landing-place lie in so many different directions, that a correct notion of them can scarcely be given even by a drawing. They are in some places erect, in others oblique, and in a third horizontal; while to each of these several positions they sometimes add the further circumstance of curvature; the chief collection of horizontal columns has a concavity turned upwards. Where they are irregularly placed they are generally of less symmetrical and decided forms than those which constitute the great southern face of the island; while they are also of a smaller size,

want of practice, and from want of habit in estimating the true value of marketable commodities: it is the general fault of those to whom commerce is not familiar.

* I beg here to remind the reader, that the perpendicular measurements are all subject to considerable variation from the varying state of the tide as well as that of the swell; and that even high water and low water mark are themselves variable, according to the time of the moon or season of the year.

rarely exceeding a foot in diameter. The beds of horizontal columns are sometimes placed on others in a vertical or oblique position, or are in other modes implicated with these. As the irregular columns approach to the surface of the island, they gradually disappear under the covering of soil; although indications of their existence are still to be seen in several places where they are laid bare; having the aspect of a pavement where their ends are visible, or else displaying portions of their parallel sides.

There appears to be a gradual increase in the size of the columns as we proceed along this shore; and at the first cave which occurs, named the cave of the scallop, or clam-shell, they are found to have undergone a decided increase of diameter. The appearance of those which surround the entrance of this cave is exceedingly remarkable, and the whole constitutes a subject for the pencil, which has however too much of the bizarre to deserve the name of picturesque. On one side they are bent so as to form a series of ribs; a disposition which has given rise to the appellation above mentioned, but has still more aptly been compared to an inside view of the timbers of a ship. On the other side, the wall which leads into the cave is constituted by the ends of columns, having a resemblance to the surface of a honey-comb. I should remark, that the longest series of the bent columns has that twist which mathematicians call a double curvature, the incurvation lying in two planes; and that a small series is seen at the bottom, with their convexities opposed to those of the upper one, which are turned obliquely downwards.

It is difficult, from the gradual manner in which this cave commences, to determine on a point whence to measure its dimensions. From that one which appeared the best, I found it to be thirty feet in height, and sixteen or eighteen in breadth; its length being

130 feet, and the lateral dimensions gradually contracting to its termination. The inside is rude, irregular, and without interest.

Immediately beyond this cave the columns become straight, although irregularly placed; their broken ends forming a rude stair, by which access is obtained from the surface of the island to the causeway and to the great cave.

Beneath this part of the cliff is situated the insulated rock called Buachaille, (the herdsman;) a name very commonly applied throughout the Highlands to remarkable mountains as well as rocks. The correspondence of the Greek term (Βουκολος) is only one, among many well known to philologists, which tends to show the common origin of the Greek and Gaëlic languages. This rock is a conoidal pile of columns rising to a height of about thirty feet from the surface of the water; and it appears to lie on a bed of horizontal columns, which is, like those before described, incurvated, with its concavity upwards. This bed is only visible about low water, in many respects the most favourable period for examining Staffa, as well as for viewing its beauties to the greatest advantage.

The columns which compose the Buachaille are, on one side, obliquely placed in a sort of conformity to the side of the cone; while the opposite one is formed by the summits of ranges of pillars gradually decreasing in length. But it is also plain that a large portion of them tend to the imaginary apex of the rock, as if they had been piled against some conoidal nucleus. All these objects, curious and beautiful as they must be considered, are nevertheless eclipsed by the superior grandeur and more regular arrangements of the erect and straight columns which commence at this point and extend to the westward; forming the great façade of the island, and containing those caves which constitute its principal points of attraction. To render the

nature of this columnar range intelligible, it is necessary to commence the description at its western extremity, which is situated above Mackinnon's cave.

The whole face is here divided into three distinct beds of trap of different characters; the lowest consisting of that conglomerate called trap tuff, the next, of the great columnar range, and the uppermost of an irregular mixture of small implicated and bent columns with an amorphous basalt. These beds dip towards the east; that dip being most sensible and most easily determined in the lowest or conglomerate stratum, because its upper surface is nearly straight. The angle of inclination with the horizon is nine degrees, as nearly as I could determine it in a turbulent sea. The thickness of the conglomerate at the western side, at about a quarter ebb, is fifty feet; necessarily diminishing as the bed extends eastward, until it reaches a point intermediate between the great cave and the boat cave, where it disappears under the water. It has been said that a bed of sandstone lies below this conglomerate. That is certainly possible, but no such rock is to be seen at the low water of an equinoctial spring tide, one of the periods at which I visited the island. I imagine that incautious observers have mistaken the basaltic conglomerate for a sandstone. This mistake may readily be made at a distance; since, independently of the smooth surface of the rock, it is thickly covered with the common Lepas, which gives it a grey colour very like that of white sandstones in similar situations. It presents one among a thousand examples, of the caution required in pronouncing on the nature of a rock from any thing short of close examination.

Next in order is the columnar bed, the chief source of the beauty and interest of Staffa. This follows the inclination of the conglomerate, but not regularly, since it is not parallel throughout; the upper surface being uneven. Hence the columns vary in length along the

course of the stratum. Near Mackinnon's cave its thickness is only thirty-six feet; while under the highest part of the rocky face, at a point not far from the Boat cave, and where the conglomerate sinks below the water, it is between fifty-one and fifty-four; the irregularity of both the surfaces preventing this from being ascertained more nearly. That is consequently the extreme height of the columns. To the eastward of this point their real altitudes can no longer be known, as their bases are skirted to a varying height by ranges of broken shafts, which, near the great cave, rise to a considerable elevation, and form a large causeway sloping gradually outwards to the sea. Partly from this cause, and partly on account of the gradual lowering of the upper surface of the columnar bed, the heights of the pillars diminish so fast, that while on the western side of the great cave they are thirty-six feet high, they are only eighteen on the eastern; from which point they go on diminishing in succession, until near the Buachaille they at length vanish altogether. As the columns are perpendicular to the plane of the bed, and the bed is inclined to the horizon, it follows that they have the same inclination to the vertical line, namely, one of nine degrees. But this inclination is only visible about the S. S. W. point, where the section of the stratum is viewed directly in front; and it then produces a very unpleasing effect to the eye, since the whole appears like a fabric that is tottering and about to fall. Fortunately for the lover of picturesque beauty, the chief views are to be found from positions so nearly coinciding with the inclination of the columns, that this defect rarely intrudes; and many have doubtless visited, and perhaps also made drawings of this façade, without having discovered it. I am even in doubt whether this inclination extends to the columns on the eastern side, but as there is no accessible position in which the eye could judge of that obliquity if it really exists, and as it is impossible

to apply the plumb line to them, this point must remain undetermined.

The columns can only be called straight when considered in a collective view, since their wavings and bendings are such that no individual perhaps is perfectly so, although there is a general air of parallelism throughout the whole. This is nevertheless widely removed from that geometrical aspect with which they are commonly represented in drawings. In this respect indeed they fall very short even of the regularity of the Giant's causeway. Near the Buachaille, a part of the principal range is to be seen, considerably bent at the top, the convexities of the pillars being outwards. The columns of the façade do not materially differ in thickness, and two feet may perhaps be considered as the most frequent diameter. Their aspect is therefore tolerably regular; but the fractures of some and the partial and secondary lights which are caught by others, in consequence of the occasional clustering of the pillars and the undulations of the front, prevent them, as much or more than their uneven outlines, from having that air of architectural regularity which I have censured in the published representations. They are very irregular in the number and position of their joints. Frequently, they are entire throughout: sometimes they have slight marks of joints, or even occasionally a decided one; while in other places these are not only numerous and decided, but notched in the usual manner by the truncation of their angles. The forms of the joints and the number of the sides are easily examined in that part which I have termed the causeway. Their surfaces are sometimes curved, with the concave sides placed indifferently upwards or downwards, at other times they are straight, and now and then they are undulated and uneven. Besides these true joints, they are often cracked by oblique fissures, which on a near view detract much from their regular aspect. In the number of sides they vary, as all basaltic

columns have been found to do; but the hexagonal and pentagonal are the predominant forms. These are intermixed with triangular, trapezoidal, and irregular prisms, and with others of more numerous sides, but rarely amounting to ten. I have mentioned two feet as an average diameter: they frequently attain to three, but very few are to be seen reaching to four feet. In one or two places, and among others at the further extremity of the great cave, they lose all form, coalescing towards their lower extremities into an irregular mass.

The differences in the frequency of the joints are important, inasmuch as they serve to explain the formation of the great cave. They are abundant in the columns which now constitute its interior sides, and it is indeed chiefly to this place that they are limited; those columns which form the faces being either entire or divided by rare and incomplete joints. The action of the sea has doubtless caused the excavation by undermining them; and is still further perhaps destined to increase its dimensions by a continuation of the process which originally produced it.

The last and uppermost bed consists, as I before remarked, of a confused mass of small columns, much bent, often very obscure, and mixed with a large proportion of rock which can scarcely be said to have even a columnar tendency, but of which the exterior surface is broken into innumerable minute parts. The thickness of this bed cannot be determined, because its upper surface, which constitutes that of the southern part of the island, is very irregular. The thickest part of it that admits of being measured lies above the highest pillars, and is fifty-eight feet: the other visible faces are often considerably thinner. Where the naked surface of this bed comes into view among the grass, it presents the same appearance of tesselated pavements and columnar ribs which was described as being found at the eastern side of the island. To those who please themselves with

drawing comparisons between the structure of Staffa and works of art, this bed represents an appropriate member in architecture; being the entablature required to give their due office to the columns which form the middle range of the front.

Quitting Mackinnon's cave and proceeding round the western side of the island, the order and continuity of the beds disappear, and are replaced by a confused mixture of the different varieties of trap, which it would be both tedious and useless to detail minutely; since in addition to the small geological interest which they possess, they present very little picturesque beauty. The most remarkable feature on this side of the island is an irregular bay immediately following the cave above named; which contains several ranges of columns, neither very striking for length or regularity, and variously intermixed with amorphous basalt, conglomerate, and amygdaloidal rocks. The further point of this bay presents two ranges of columns with a mass of amorphous rock interposed. Two hollows, scarcely deserving the name of caves, may here be seen; and I may remark, that all the columns which occur on this side are in an erect position. The northern end of the island becomes low and nearly even with the water, but is chiefly columnar. After this the cliffs rise once more into vertical and broken faces composed of the different non-columnar varieties already described. There are five small caves in that part of the cliff which looks toward the north-east; remarkable for nothing but the noise, resembling heavy and distant discharges of ordnance, which they make when the surge breaks into them. Immediately after this point we return to the place from which the description commenced.

This general account of Staffa would be considered incomplete were I to omit those caves on which its celebrity is chiefly founded, and by which it is distinguished from most of the basaltic islands in this sea. That they

have been already described by others, would not render the blank less sensible here.

The westernmost of the three which lie in the great south-western face, is known, as will already have been perceived, by the name of Mackinnon's cave.* The traditions respecting this hero are nearly as obscure as those that relate to Fingal, although, to judge by the places to which he has given his name, his celebrity has not been inconsiderable. This cave is much less known than that of Fingal. It is however much more easy of access from the water, both on account of its greater breadth, and because the entrance is free from the rocks which narrow the channel and cause the sea to break into the latter; whence a boat can often enter the former when that is inaccessible.

The height of Mackinnon's cave from the water, at a quarter ebb, is fifty feet, and its breadth forty eight, so that it presents a large square opening, which, from its depth, catching dark shadows, produces a powerful effect; equal perhaps to that of the great cave, although neither attended by the same symmetry nor elegance of design. The length is 224 feet, and the interior dimensions throughout are nearly equal to the aperture; excepting at the extremity, where the roof and walls approach a little, and a beach of pebbles is thrown up. It is thus of a parallelogramic shape; and as it is entirely excavated in the conglomerate bed, the walls, as well as the ceiling, are, with slight exceptions, even and smooth. It occupies precisely the thickness of this bed, which also forms its external sides. The form, as well as the fracture of this rock, is inelegant; in consequence of which the internal appearance of this cave is, like most of the exterior, deficient in that kind of beauty arising from order and regularity which is so remarkable in that of Fingal, although in many respects grand and powerful in effect. The superior

* Sometimes the Scart, or Cormorant's cave.

part of the front is more beautiful. It consists of a range of columns, hollowed into a concave recess above the opening; while the upper part of this colonnade, overhanging the concavity, presents to the eye a sort of geometric ceiling; the inferior part being thus thrown into a secondary mass of shadow which conduces much to the general effect of the whole.

The next cave is situated more to the eastward and is known by the name of the Boat cave, apparently because it is accessible only by sea. However insignificant in dimensions, it is far from being so in picturesque effect, since the symmetry of the columnar range in that part of the face under which it lies is even greater than near the cave of Fingal. Its height is from fourteen to sixteen feet above the high water, the undulation of the sea preventing greater precision in the measurement, and its breadth is twelve feet. The roof and sides are smooth, and the whole interior presents a long parallel opening like the gallery of a mine, without interest or beauty. By some accident the measure of its length was lost, but from a general recollection of the progress of the boat to the inner end, that cannot be less than 150 feet. It is situated near the central part of the range, which here retires with a gentle concave sweep; thus producing, either with a morning or evening sun, a noble and tranquil breadth of shade, finely softening into the full light by a succession of smaller shadows resulting from the irregular grouping of the columns. A concave recess of the columns immediately above it, catching a broad and secondary mass of deeper shade, adds much to the grand style of the composition, as well as to the playful variety of the surface; while the eye of the picture is found in the intense darkness of the aperture, which gives the tone to the whole. The effect of such obscure parts in giving value to surfaces highly divided and ornamented, is well known to architects; and striking examples of it may be found in many of the Gothic buildings

in England. Those who have seen the front of Peterborough cathedral, will be at no loss in understanding the effect to which I allude.*

Description has long since been exhausted on the cave of Fingal.† If too much admiration has been lavished on it by some, and if, in consequence, more recent visitors have left it with disappointment, it must be recollected that all such descriptions are but pictures of the feelings of the narrator. It is moreover as unreasonable to expect that the same objects should produce corresponding effects on all minds, on the enlightened and on the vulgar, as that every individual should alike be sensible of the merits of Phidias and Raphael, of Sophocles and Otway. Let those who have a taste for the grand and the beautiful, and who, from the cause above mentioned, may have quitted Staffa with a sensation of disappointment, return to this cave again, and again view it, regardless of the descriptions of others and their own ill-founded anticipations. They will then become sensible of its beauties, and feel ready to describe it in terms which may excite equal disappointment in those who shall follow, and who may, like themselves, vainly expect that the feelings of one individual are the measure for those of another, or that any thing can exist which the imagination is not ready to exceed. Whatever disappointment may, on a first view, be experienced from this cause, will

* The want of that relieving shadow must be no less felt by a cultivated taste in contemplating the beautiful tower of Gloucester cathedral, where the richness of the ornamental work is obscured, and in a great measure lost, in consequence of the wooden divisions that fill the windows. These, catching a multiplicity of small lights, dazzle the eye and distract its attention; producing an uniform minutely divided surface, where the architect undoubtedly intended contrast; the object in view in the magnitude and structure of the windows being apparently that of relieving the ornaments which surround them.

† I use this name in conformity to the present custom, but it is of recent introduction. The Gaelic name is Uaimh binn, the Musical Cave; a term probably derived from the echo of the waves.

thus be removed; while after every visit this object will progressively rise in estimation. There is no stronger proof of merit, either in the works of art or of nature. Those who can look back to their own experience in the arts will confirm the truth of this remark; those who have no experience of their own, will perhaps recollect the observations of Sir Joshua Reynolds on this subject.

This cave lies near the eastern end of the principal face, a small part only of the columnar range being visible at that side; and from this cause it is deficient in that external symmetry of position which forms so beautiful a feature in the little cave last described. The outline of the aperture, when viewed in such a light as to show it distinctly, is perpendicular at the sides, and terminates above in that species of Gothic arch which has been termed the contrasted; a form which, from its obvious want of geometrical strength, is, in architecture, unpleasing, however abstractedly elegant its curvature may be. Here, it is in character, and the defect is not felt. The height from the top of the cliff to the top of the arch is thirty, and from the latter to the surface of the water at mean tide sixty-six feet. On the western side the pillars which bound it are thirty-six feet high, while at the eastern they are only eighteen, although their upper ends are nearly in the same horizontal line. This difference arises from the height of the broken columns which form the causeway on the eastern side, and which cover and conceal the lower parts of those belonging to the front. The breadth at the entrance is forty-two feet, as nearly as it is possible to ascertain it; since the gradual variation of the surfaces, as the curve retires on each hand, prevents the adoption of a very precise point of measurement. The height of the cave within, diminishes very soon to a mean measure varying from fifty to forty-four feet; which latter, in the same state of the tide, is also the altitude at the extremity. The mean breadth is equal to that of the aperture, till near the innermost part; but at the extremity it diminishes to

twenty-two feet; preserving, as will be seen by these measures, a considerable degree of regularity throughout. The length is 227 feet.* The sides of this cave are, like the front, columnar, and in a general sense perpendicular: though when accurately viewed, they are, in the same way, far from possessing that geometric regularity which accompanies all the views of it hitherto published. The columns are frequently broken and irregularly grouped, so as to catch a variety of direct and reflected tints mixed with unexpected shadows, that produce a picturesque effect which no regularity could have given. The ceiling is various in different parts of the cave. It is deeply channelled in the middle by a fissure parallel to the sides and prolonged from the point of the exterior arch to the end. That portion which lies on each side of this fissure toward the outer part of the cave, is similar to the upper incumbent bed, being formed of a minutely fractured rock. In the middle it is composed of the broken ends of columns, which produce an ornamental and somewhat architectural effect; while at the end, a portion of each kind of rock enters into its formation. From attending only to one or other of these portions, different observers have described the ceiling in a different manner; and each party has accused the other of misrepresentation. The surfaces of the columns above, are sometimes distinguished from each other by the infiltration of carbonat of lime into their interstices. As the sea never ebbs entirely out, it forms the only floor to this cave; but the broken range of columns which produces the exterior causeway, is continued on each side within it. This range is most perfect at the eastern side, and admits of access over the broken summits to the further end,

* These measures were all taken with great care. If there be any differences between them and former measurements, they may have arisen from the impossibility of different observers choosing the same points in an irregular surface.

provided the water be not too high; but on the western, they terminate at some distance from the extremity. The lower portions of the last columns lose at length their regularity of form, and coalesce into a rude mass of rock, as I have already remarked.

It would be no less presumptuous than useless to attempt a description of the picturesque effect of that to which the pencil itself is inadequate. But if this cave were even destitute of that order and symmetry, that richness arising from multiplicity of parts combined with greatness of dimension and simplicity of style, which it possesses; still, the prolonged length, the twilight gloom half concealing the playful and varying effects of reflected light, the echo of the measured surge as it rises and falls, the transparent green of the water, and the profound and fairy solitude of the whole scene, could not fail strongly to impress a mind gifted with any sense of beauty in art or in nature. If to these be added, as in viewing the Scuir of Egg, that peculiar sentiment with which Nature perhaps most impresses us when she allows us to draw comparisons between her works and those of art, we shall be compelled to own it is not without cause that celebrity has been conferred on the cave of Fingal.

The most interesting views for the artist are to be found from various points on the southern side of the island; comprising the whole range of pillars, with the apertures of one or of all the caves. But these are still less subjects for description, and must be left to the painter, whose art will not often meet with objects more worthy of its exertions.

I HAVE reserved to the last place the geological account, both of the rocks and of the foreign substances found in Staffa, which present but little that is interesting.

The conglomerate that forms the lowermost bed to the south-west, and is also found in several other parts of the

island, consists of a black basaltic rock containing fragments of the same substance, sometimes more compact than the matter of the bed, at others amygdaloidal or cavernous. Where the sea washes it, the fragments are generally distinguishable, partly by their superior durability and consequent projection, and partly by their resisting the adhesion of the common Lepas which covers the other parts of the rock.

The basalt which forms the substance of the columns, is of a dark greyish black colour and of an uniform compact texture, somewhat sonorous and very brittle; breaking with violence into sharp and thin fragments, or into irregular angular masses. When bruised, it has an obscure green colour, and the powder is of a muddy and greenish white. It is difficult to ascertain truly its composition by the magnifying glass, the particles of which it is composed being extremely minute; and it is sufficiently evident that no mode of analysis, chemical or mechanical, is applicable to an investigation of this nature. As far as can be perceived by the lens, this rock seems to consist of a large proportion of a dark grey substance mixed with a smaller one of a black colour; but it is impossible to ascertain to which of the two the green colour of the powder is owing, as the minutest scratch that can be made involves both. It is not improbable that it is a minute compound of augit with compact felspar; an opinion somewhat countenanced by the peculiar green colour of the powder, and by the great prevalence of this mineral among the traps of the Western islands. Whatever dissimilitude the basalt of Staffa may bear to those of Germany, or to the well characterized examples of this substance which occur in this country, it does not appear possible at present to separate it from them by any mode of definition; and we must therefore be content to call it by this name until we shall have acquired a more thorough acquaintance with the several varieties of this multifarious family, and shall have discovered a method of distinguishing and defining them. I shall only add that it cannot be distinguished

from that of the Giant's Causeway. It becomes of a rusty brown on weathering, but decomposes no further. It is this dark brown hue, seldom enlivened by the growth of a lichen, but oftener blackened by the dripping of water, that produces the sombre tone of colouring which is the chief defect of Staffa as a picturesque object. The yellow stain given by the Lichen parietinus to some parts of the upper stratum, is scarcely sufficient to relieve this uniform darkness; nor does this substance form with it a happy combination of local colour.

The amorphous basalt found in various parts of the island, is precisely of the same texture with the columnar; and contains in various places amygdaloidal cavities, which are however most abundant in the soft or tufaceous varieties.

The zeolites are chiefly situated in this latter rock; yet they occur, although very rarely, in the solid, and even in the columnar basalt. They are seldom remarkable either for their size or beauty; being far inferior in both those respects to the specimens found in the other basaltic islands of this country. These nodules consist either of analcime or mesotype; and are more commonly solid than crystallized. In one place I observed specimens of that substance which is formed into concentric and radiated spheres, and of which some foreign varieties have been distinguished by the name of natrolite. Stilbite is more rare, and appears chiefly to be disposed in very thin veins occupying fissures in the basalt; in which situation also is found the little calcareous spar that occurs in the rocks of this island.

The last extraneous substance, if it may so be considered, is the basalt of those veins by which the fundamental rock is traversed; a circumstance from which no part of these islands, whether basaltic or not, seems to be exempted. They are not numerous nor of very large size. The largest is found in the lowermost

stratum towards the western side, which it intersects in a vertical direction; and having yielded, as is generally the case, to the action of the sea, it has left a large fissure. A second may be observed intersecting the lateral and western wall of Mackinnon's cave, and a third is seen among the large columns on the eastern side of the cave of Fingal; running among them in a parallel course so as not to be readily distinguished.

But I must not quit Staffa without describing a bed of matter which, however foreign to the structure of the island, is by no means foreign to its mineral history; giving rise, at the same time, to geological questions of considerable importance. This is an alluvial deposit consisting of various transported stones, which may be seen on the surface in different parts of the island. It is particularly conspicuous near the landing-place, and on the western abrupt edge of the cliff. The fragments are of various kinds, consisting of quartz, granite, and blue schist, intermixed with blue quartz rock, and trap; all of them being substances which enter into the composition of the neighbouring islands of Rum, Sky, and Mull, but which are found *in situ* no nearer than in the latter island. I have on different occasions throughout this survey remarked how rarely foreign alluvial matter occurs in the Western islands. It is here therefore the more remarkable; while the distance of Staffa from the neighbouring shores of Mull, which is not less than seven miles, adds not a little to the interest attending it. The surface of the earth every where presents appearances indicating great changes and revolutions; of which none are perhaps more unquestionable than the existence of transported stones and alluvial substances in countries far removed from those where similar rocks are now found in their natural situations. These are familiar to geologists, and have been subjects of much discussion. The insular position of the example now under consideration, is sufficient to prove that it could not have resulted from the flow

of water, whether that flow was gradual, or sudden, without at the same time supposing a state of the surface in which Staffa was continuous, at least with the neighbouring island of Mull. If we imagine the origin of the alluvial matter to be in that island only, it is sufficient to prove the great changes which the surface must have undergone since the period of this transportation. There is scarcely any other method of explaining the present position of this deposit but by supposing that the island of Staffa had been protruded from below in its present form; a supposition involving changes at least as great, and less consistent with those revolutions of the globe which seem most numerous and most strongly indicated. A contemplation of the map will give the reader a notion of the great waste of land which must have occurred before the present separation of Staffa from Mull was effected. Whether this loss of surface has resulted from the violent or slow action of destroying forces, we have no means of knowing. Yet perhaps the undisturbed state of the trap strata, an argument which I have illustrated at more length in speaking of Mull, tends to show that this separation was not effected by dislocations, the consequences of force exerted from below; but that it has been gradual and tranquil, or the result of powers at least which have allowed the neighbouring parts to remain in their original state.*

* On that midsummer evening which terminated the preceding observations on Staffa, the sun had set far toward the north, but the red twilight was still shining at midnight on the grey mountains of Mull and the walls of Iona; its colour being reflected on a sea that was tranquil as a mirror, and every object around in repose. We had been busily employed from five in the morning, and, like the sea birds that were floating by us on the silent water, the seamen were sleeping on their oars. While the helmsman alone watched for all, the idea of the present work first suggested itself to his mind. If the reader shall derive instruction or entertainment from it, he has not, for many perilous and busy months, and in seas of a far different character, watched at the helm in vain.

ST. KILDA.*

THE remote and solitary position of St. Kilda has continued, ever since the days of Martin, to confer on it an interest to which it is scarcely entitled from any peculiarity either in the manners or the condition of its inhabitants. The spirit of romance seems still to reside in the clouds and storms which separate this narrow spot from the world, but, like other spirits, vanishes before the rude touch of investigation. Yet the difficulty of communication with even their fellow countrymen, and the ignorance in which the inhabitants are destined to live, of the manners, events, opinions and improvements, of the world at large, are sufficient to excite some unusual curiosity in the traveller whose amusement it may be to study the varieties of human life and manners.†

The appointment of a resident clergyman in this island

* See the Map of St. Kilda, and also the general Map.

† Previously to my arrival, more than a year had elapsed since any one had visited the island. The appearance of an armed vessel brought the whole population down to the beach, nor could we help admiring the courage of the chief personage, then, as it happened, the wife of the Minister, who hailed us with the important question "Friends or enemies?" They had remained in ignorance of the escape of Napoleon from Elba, and of the subsequent events which had agitated Europe, then but just subsided. Here indeed was the bliss of ignorance, if ever it could concern an inhabitant of St. Kilda, what dynasty ruled in France, and how the balance of power was to be readjusted. They received with little emotion the news of his defeat and surrender, together with that of his previous escape and re-establishment. The peace with America was a matter of more interest, since there was here an immediate prospect of participation in the effects of war. Their remote and defenceless island was subject to depredation from the ships of that enemy; who had in various places given proofs of his knowledge of the country, by burning vessels in the harbours and plundering the islands of cattle. It was an evil also, not among the least, to a maritime Highlander, that the Ame-

has in all probability produced a good effect both on the manners and information of the inhabitants. This establishment is supported by the Society for the Propagation of Christian Knowledge in Scotland, and is now of twenty years' duration. The salary is £35 per annum, and the church service is performed in a house that was erected as a store for the wool and feathers of the natives; the chapels described by Martin having disappeared. It is to be regretted that the duty of a schoolmaster has not been combined with this office; for want of which, independently of more important considerations, the children are still ignorant of English; a language which, in most parts of the Highlands, they are now fast acquiring, and which bids fair, in a few generations, to expel the original tongue, since a people rarely maintains two languages long. This is an event much to be desired; as, besides the inconvenience attending a population of which the one portion does not understand the other, the association of the Gaëlic language with early prejudices and bad habits, offers one of the great impediments yet remaining to the improvement of the Highlands.*

rican war had an influence on the price of tobacco; that bribe which gains immediate access to his heart and services.

The politics of Europe being settled, it became a contest who should be nearest or render the greatest number of good offices; the whole male population down to the age of seven attending my progress throughout the island with a civility at least equal to their curiosity. The *following* of an ancient chieftain could not have been more attentive and have probably seldom been so happy. He who is ambitious of distant fame need only visit St. Kilda; he will assuredly be recorded in its annals.

* The establishment of Gaelic schools is, in this view, an evil to be deprecated; and must be considered as the result of national affections, unchecked by that good sense which these prejudices, in other cases than this, are so apt to observe. I am aware however that this is delicate ground: more especially for the descendant of a Gaël, and for one who still expects to wander among the Gaël. But it is difficult to discover what countervailing advantages can arise from the cultivation of a rude language, now inadequate

Traces of a Danish origin are perceptible in the people of St. Kilda, a remark frequently applicable to the Western isles. But the language is nevertheless, as elsewhere, pure; no objection to its purity was at least made by the Argyll Highlanders who accompanied me. The men are well looking, and better dressed than many of their neighbours of the Long island; bearing indeed the obvious marks of ease of circumstances both in their apparel and diet. The children may even be considered handsome; but the women, like the generality of that sex in this country, are harsh in feature, and impressed with the marks of age in very early life.

The population consists of twenty families, containing, at the time of my visit, 103 individuals. They are so much attached to their home that a native seldom leaves the island. On account of the absence of the minister, I was unable to discover whether or not they were at present in a state of increase. If not, that must here be counteracted by circumstances not easily conjectured; since it is decidedly felt in all those insular situations where a similar attachment exists; being productive of great misery. As the soil is good, and but a small portion of it is as yet cultivated, there is still room, in the resources which agriculture offers; independently of that arising from fishing, an occupation in which they have never yet engaged. The vacillation which has taken place in the population of St. Kilda is remarkable, and has not been explained by Macaulay, the latest writer on this island. In his time, about forty years ago, it was lower than it is at present, whereas in the time of Martin it was nearly double. By the account which he has given, they were then in a state of great poverty; whereas in Macaulay's time they were at their ease;

to the improved state of society, in which no books have been written, and of which the literary value is confined to a few traditional poems. For philological purposes, it is sufficient if it exists in the libraries of the grammarian and antiquary.

effects naturally resulting from these different states of the population. It is in a limited and insulated spot like this, that some of the immediate causes which influence population might perhaps be advantageously traced; but unfortunately no facts can be collected towards this object from a people who have little to attend to beyond the wants of the passing day.

The neglect of fishing proceeds from the wealth of the inhabitants. They possess already as much food as they can consume, and are under no temptation to augment it by another perilous and laborious employment added to that to which they seem to have a hereditary attachment; while their distance from a market, and the absence of commercial habits, prevent them from undertaking a fishery for the purpose of foreign sale. Yet the coast abounds in cod and ling, and may hereafter perhaps prove a source of increased population; if not of a greater disposable produce, and consequent increase of rent to the proprietor. They possess at present but two boats, of which one only is serviceable; and their indifference to this kind of property and the accommodation it affords, is marked by their improvidently suffering the other to go to decay on the shore for want of a few trifling repairs. With the effective one they make a voyage once or twice in the year to the Long island, to dispose of that part of their wool, feathers, and cheese, which is not required for payment of rent; purchasing with them such commodities as are wanted for the uses of their limited establishments. The rocks which skirt the shore near the village are smooth and inclined so as to admit of boats being drawn up with great ease; nor would it be a work of much labour to build a pier for the security of the few boats required for a fishery, should that be found necessary.

The rent of the island is £40, which, according to the present average of Highland farms, and including the value of the sea fowl, is a very low rate. It is paid in feathers, the produce of the innumerable birds that frequent its cliffs to breed; and which form at the same

time a principal part of the food of the inhabitants; being both consumed fresh and salted for winter use.

The cultivation resembles that of the Long island in general; consisting chiefly in barley, which is by much the finest to be seen in the whole circuit of the isles. The oats are much inferior in quality, and are but scantily cultivated; nor are potatoes grown to nearly the extent usual in Highland farming. The cultivated ground is limited to a narrow spot close to the little crowded cluster of houses that forms the village, which is characterized by a feature unknown in Highland villages elsewhere, a stone causeway. The land is held conjointly, according to the old and barbarous system of run-rig; and the allotment of farms would obviously be the first step towards increasing the value of the island. Except on the highest hills, the soil is every where of an excellent quality, and might be cultivated to a greater extent. But the violence of the winds is an obstacle to its extension on the west side, where the finest soil, and consequently the best pasture, is found. This pasture is occupied by sheep and black cattle, very few horses being used: a few goats also wander about, kept chiefly for the purpose of milking. The land, like Canna, presents one carpet of fresh verdure, not a single plant of heath existing in the whole island, which is clothed with grass to the very summit. The peat which is used for fuel occupies a range on the highest ridge, and is abundant, although not of a very compact quality. Much of it is consumed in the manufacture of salt, a process which forms part of the necessary economy of every cottage.*

The provision made for wintering, not only the peat but the corn and hay, is ingenious, and peculiar to this island. Yet it appears from the accounts of the Roman writers that an analogous practice once existed in the interior islands. It consists in numerous buildings, scattered over

* In some of the islands it is not unusual to salt the cheese with the ashes of sea ware; with kelp.

the eastern face of the hill above the village, in the form of hemispherical or semi-ellipsoidal domes; the purposes of which appear to a stranger as inexplicable, as their numbers excite his surprise. They are indeed the first marks of human art visible in approaching from sea, and are at first naturally supposed to be the habitations of the natives. It is in these that the peat, the hay, the corn, and even the winter stock of birds are lodged. They are very ingeniously built, the sides admitting the free passage of air, while the roofs are rendered water-tight by a covering of turf. The stones are laid without lime, an article which they do not possess, and the dome is very artificially turned by the regular diminution of the courses; the whole being closed and secured at the top by a few large and heavy stones. Compared with the slovenly expedients of the Highlanders in general, these buildings speak much in praise of the industry and ingenuity of the natives; and present indeed a practice worthy of imitation, to those inhabitants of the rainy parts of the Highlands whose peats and crops are frequently rendered useless by the continuance of a rainy season. The grass and corn are thrown loosely into the dome as soon as they are cut, and are thus secured from all future risk.

In the construction of their dwellings they resemble the greater number of their continental neighbours, the roof being carried from the outer side of the wall, and not from the inner, in the barbarous manner practised in Sky, in Barra, and in other places.* The interior is,

* In the Highlands in general, the ancient habits of keeping the cattle under the common roof are still preserved; the simplicity recorded with approbation by Juvenal, and related by Herodotus of the Egyptians of his day. But I did not understand that the practice of making manure in the house, as mentioned by Macaulay, was now in use here. In the old town of Stornoway it is however still thus conducted, in a manner perfectly incredible. Cleanliness is a virtue of compulsion. In a village where the proprietor had obliged the inhabitants to remove the dunghils from their doors, one of them boasted that he had cheated the Laird by taking the "midden into the house."

as usual, smoky and dark, but each house has a door with a wooden lock and key, a luxury quite unknown in other parts of the Highlands. Among the houses are still to be seen the ruins of that which was so long the prison of the celebrated Lady Grange, whose story is attended with circumstances so romantic, that it is difficult to believe it could have occurred in times so recent. The traveller will be amused to see the sea gulls sitting on the roofs of the houses with the familiarity of pigeons; unnoticed by, as unnoticing their natural enemies.

The sheep of St. Kilda are of the ancient Highland, or Norwegian breed, now nearly extirpated every where else; and among them are many of the brown fleeced variety, natives alike of Iceland. I was unable, from the absence of the minister, to procure an account of their numbers, or of those of the other cattle. The milk of the ewe is manufactured into cheese, being mixed with that of the cow and goat, this forming one of the articles of export. The whole surplus of the cattle is consumed in the island; the long navigation preventing any exportation of live stock, and ships universally avoiding the coast from an evil reputation it has acquired among mariners. This want of commerce however, prevents that acquisition of disposeable wealth which would speedily find its way to the landlord in the form of rent, and is thus the cause of the superior condition of the inhabitants, when compared to those of the Long island where there is a regular demand for the produce of pasturage: they are hence the only Highlanders who have the command of animal food. The pampered native of St. Kilda may with reason refuse to change his situation; finding his amusement where his chief occupation lies, in the pursuit of the sea fowl, that constitute at the same time his game, his luxury, and a considerable part of his wealth. Free from the reputed evils of law, physic, politics, and taxes; living under a patriarchal government, among a social circle of his relations; in a mild climate, without know-

ledge of a higher state of things; if he thinks not his island an Utopia, the pursuit of happiness is indeed a dream.

The island produces several streams of fine water, the principal of which is on the western side. They are sufficient at all times to turn a mill; and the establishment of one would supersede the use of the quern, the labour of working which is considerable.* This ancient, but rude instrument, is found in every house, and consigned from time immemorial to the female; it is now rarely seen elsewhere. Distillation is unknown here, and the use of spirits equally so, nor is any beer brewed. It is probable that their produce is insufficient to meet this additional demand; as the expedients for carrying on a distillery in the Highlands are so simple as to be easily commanded.

The reputation of the bird-catchers for dexterity and courage has long been celebrated. The puffins are taken in their burrows by small dogs; this chase being generally conducted by the children both male and female, while the men are employed in higher game. The gannets and larger birds are taken by hand, or with snares, on their nests; the bird-catchers descending the cliffs by the assistance of a rope of hair secured above. Accidents are extremely rare. The various sea fowl which frequent the island have been enumerated by Martin;

* The expense of a Highland mill is no obstacle, as it does not amount to a great many shillings. The stones are about three feet in diameter, the upper being fixed on a vertical axis that passes through the lower and through the floor of the hut, which is built on the edge of a rock or bank over some stream. This axis is about four feet long, working on any casual stone by an iron pivot, the only iron in the whole construction. Sixteen or eighteen rude sticks, scooped at the outer ends like a spoon, are driven horizontally into it, their flat sides being vertically placed to catch the stream directed against them. The hopper is suspended by four strings from the roof of the hut, which is scarcely sufficient to contain a man upright. It would not be easy to construct the horizontal water mill on cheaper terms.

and more recent naturalists have not added any to his list.

Here, as elsewhere, the ancient popular superstitions seem to have disappeared; that of the power of an evil eye, the only existing one, is equally common even in the Lowlands to this day. From increase of civilization, it is probable that they are now equally forgotten every where throughout the country. In truth there appears no difference between the present inhabitants of St. Kilda and those of the neighbouring islands. At the time that Martin wrote, the manners of the islands in general were far different from what they are at present.* Had these people remained stationary while the others were advancing, there would indeed have been now an essential difference; but while Martin's book continues the standard of our judgment respecting them, they have sailed down the stream with their neighbours, the anchor alone remaining to indicate where the vessel once lay.

One popular notion among the natives of St. Kilda has excited much curiosity, and can name adherents even to the present day: assuredly if testimony were always a sufficient ground for belief, it would be difficult to refuse our assent. That Dr. Johnson declared his belief in it,

* Of the changes in Highland manners none are more remarkable than the peaceful conduct which has succeeded to the ancient turbulent habits; which extended even to meetings of business and of festivity. The feast of knives is well known. The principle of pugnacity is not however absolutely dead.

When in Sky, there was a sermon in the churchyard, and the usual conversations succeeded. In the midst of these, one man marked out the place of his future grave. As the example spread, it soon proved that the space was insufficient for the claimants, or that the choice of one was an object of envy to another. A regular battle ensued, the combatants doubtless forgetting the very undesirable title by which alone possession could be secured. In the days of the Claymore and Skian, there is little doubt that some of the disputants would have secured their rights to this visionary freehold. Nations have been sometimes accused of warring for imaginary objects; not often for any of so little satisfaction to the victor.

although no probable explanation could be assigned, may perhaps be a sufficient reason for noticing it here; although it will not afford an additional argument in favour of its credibility. It is asserted that on the arrival of a stranger, all the inhabitants, (in the common phraseology,) catch a cold; an event so ludicrous as scarcely to admit of a serious examination. The question was put by us to the inhabitants, who unanimously agreed in the story; the minister's wife, then regent of the island, repelling the notion of a doubt with as much indignation as she would that of the truth of her catechism. I need scarcely say that a cross examination of the evidence produced no instance of the fact itself, although abundant examples of a belief in it. Credible witnesses have never been wanting in support of witchcraft and demoniacal influence. The greater facility which the mass of mankind finds in believing than examining, together with the natural love of the marvellous, will probably continue to persuade the natives of St. Kilda of the truth of this catarrhal visitation, although every year's experience should contradict it as effectually as my visit. Believers of a higher class who have given their assent to this tale, either from unwillingness to doubt a positive assertion, or from some latent regard for extraordinary and occult phenomena which they would fain conceal even from themselves, have attributed it to the east wind, which they have supposed necessary for the landing of a boat. This theory is unfortunate, since no wind renders landing so impracticable, as it blows right into the bay and raises a surge on the rocks. But enough of this.

To have circumnavigated the Western isles without even mentioning the second sight, would be unpardonable. No inhabitant of St. Kilda pretended to have been forewarned of our arrival. In fact it has undergone the fate of witchcraft; ceasing to be believed, it has ceased to exist. It is indifferent whether the propagators of an

imposture, or of a piece of supernatural philosophy, be punished or rewarded. In either case the public attention is directed towards the object; whether by the burning of the witch, or by the flattering distinction which attended the Highland seer. When witches were no longer burnt, witchcraft disappeared: since the second sight has been limited to a doting old woman or a hypochondriacal tailor, it has become a subject for ridicule; and, in matters of this nature, ridicule is death.

Among other subjects which do not appear to have stood the test of examination, St. Kilda has been celebrated for its music. That reputation, if it was ever well founded, exists no longer; nor, at the time of my visit, did it appear that there was either a bagpipe or a violin in the island. The airs which are recorded as originating in this place, are of a plaintive character; but they differ in no respect from the innumerable ancient compositions of this class which abound in the Highlands. Collections of these have been formed by the musical antiquaries of Scotland, although many still remain unrecorded; and they deserve the study of those who may occupy or amuse themselves in tracing the progress of this art. They are interesting also in an historical view; as they appear to be the true origin of that peculiar style of melody for which Scotland is celebrated, and concerning which so much has been said and written.

In examining the Highland airs of acknowledged antiquity, as well as those of more modern date which have not deviated from the ancient model, they are found distinguished chiefly into two classes. The pibrach is of an extremely irregular character, being without time or accent; and often, scarcely containing a determined melody. On this basis, such as it is, are engrafted a train of variations; gradually rising in difficulty of execution, but presenting no character; as they consist of a series

of common place and tasteless flourishes, offensive to the ear by their excess, and adding to the original confusion instead of embellishing the little air which the groundwork may possess.

The other class of compositions is of a distinct character, and commonly of a plaintive nature; being divisible also into a regular number of accented bars. These are often in a minor key; while the melodies are so little varied that it requires some experience in them to discover the difference among a great number. The more ancient appear to have consisted of one strain only: the second strain so often found attached to them at present, and invariably attending the more modern compositions of the same nature, is generally a more recent addition; wandering commonly through a greater extent of the scale, and not often a very felicitous extension of the same idea. In some cases these airs appear to be purely instrumental; in others, they are attached to poetry and sung by the milkmaid at her summer shealing or the cowherd on the green bank. One peculiar circumstance attends nearly the whole; namely, that they equally admit of being played in quick time. Thus they are often also the dancing tunes of the country; nor is there any essential distinction between the reel and the pathetic air; the same character, and even the same melody, pervading both. Exceptions to this general rule need not be noticed at present, as the nature and causes of these will shortly appear.

It is well known to musicians, that the Scottish airs of genuine character are composed on a scale which does not contain the fourth and seventh of the modern diatonic scale of music. From this is derived the peculiarity by which they are immediately recognised, as well as their general similarity; nor is it possible to move through a succession of these intervals, without producing the semblance of a Scottish air. The same scale, it has been long known, is in use among the Chinese, and hence the

melodies of that people possess the Scottish character. The airs recently collected in Java are precisely similar, and prove, that among the Javanese also, the same system of intervals is in use. We are not sufficiently acquainted with the musical history of those nations to know from what source that scale was derived. The nature of the musical scale, in any case, has indeed been a source of much difficulty; nor has it yet been determined by musicians whether its foundation is to be sought in art or in nature. It is probably in a great measure artificial.

In Scotland, the bagpipe must be considered as the national instrument. The scale of this consists of the complete octave with an additional note; the fourth, and particularly the seventh, being so imperfect that they are never used as fundamental parts of the melody. When introduced, they are treated as passing notes. By this instrument the characters of these melodies seem to have been regulated, as they appear to have been composed on it. In examining all the most ancient and most simple, they will be found limited to its powers and rigidly confined to its scale. The introduction of the violin into that country is modern; as indeed the instrument itself is of comparatively recent invention, although it is now impossible to know at what period it was introduced. Soon after its introduction, doubtless, innumerable airs were composed on it; although, even in these, the same imperfect scale has been used, and the airs therefore preserve their original characters: in more recent times these have become exceedingly multiplied, modulating into a greater number of keys, ranging through a much wider extent of intervals, and adopting successions of notes incapable of being executed on the bagpipe. It is in attempting these, that the dissonance and false intonation of that instrument is particularly felt; although, even within the limits of its own powers, it is still sufficiently false. The endeavour to execute them leads also to a perversion of the original melody; and the effects hence

produced are such as no ear could be supposed to endure, were there not daily proof to the contrary in the joy that accompanies the national and characteristic dances, where the bagpipe is employed in executing the most refined of the dancing melodies. In these more modern compositions however, the same character has still in a great measure been preserved; exceptions of course being made of those airs which have combined with the genuine character derived from the scale of five notes, the musical phrases of a better school. The limited range of the pipe has given rise to another feature strongly characterizing the Highland melodies; no less so indeed than the nature of its scale. This is the irrelative transition from the major key to the minor on the second of the scale, or the reverse; a peculiarity highly offensive to all but Highland ears, which tolerate as good harmony an air in the minor A on a drone bass in G.*

In thus stating the claims of the bagpipe, as a fundamental cause of the peculiarities of the Highland melodies, it must be remembered that the harp also, appears to have been known to the Highlanders. Having long since fallen into entire disuse, its former existence has naturally been doubted, and the industry of antiquaries has thus been excited to prove it. When matters, which ought to be of common notoriety, require the species

* The facility with which the human ear adapts itself to false intonation, as well as to false harmony, is not a little remarkable. The Highland piper considers his pibrach, or his reel, to be the perfection of melody, as he thinks his unvarying drone the essence of harmony. To render the bagpipe true by a better method of boring, and by the addition of a few keys, would be considered a crime no less than that of adding a string to the Greek lyre in former times. A piano forte in this country is rarely tuned from the time it was made, yet is played on without remorse. Musicians can find a parallel case, when the essence of harmony was considered to lie in a succession of fifths; when "quintoyer" was synonimous with harmony. The artificial nature of this invention is not a little exemplified by comparing the effects of such a system with those of the recent works of Mozart and Haydn.

of proof which has been brought forward for that purpose, conviction does not easily follow. The instrument has doubtless existed, but it may still be questioned if it was common. An ancient harp is now to be seen at Lude in the possession of General Robertson, which is said to have been brought from Argyleshire in 1460. But if it be ancient, it is also the most recent instrument of this construction existing in the Highlands; and since that time at least, the use of the harp has been unknown. It may perhaps more properly be regarded as an exception than a rule. Had it been common, it could not have been so difficult to find, either specimens, or indisputable traces of its use. The specimen in question is said to resemble that of Brian Boromhe, well known to musical antiquaries; and it is, not improbably, also of Irish origin. The other direct evidence which has been adduced for this purpose, is perhaps sufficient also to prove that this instrument was known, but by no means that it was universal, or even common. The opinions of Gunn deserve respect; but the evidence supposed to be deducible from the poems of Ossian is, for many obvious reasons, nothing. Nor can any argument be derived from the terms Clear, Clearsach, Tiompan, or Cruit. The real nature of the instruments to which these names were applied, is unknown: the latter, indeed, would rather appear, from similarity of sound, to have been the Crwth or Crowd; a variety of the rebec or violin, and an invention of no very ancient date. The evidence derived from terms is of little avail, unless their precise meaning could be ascertained. The Harper's window is pointed out at Duntulm castle, and the Harper's field in Mull, while similar memorials are not wanting in many other places: but there is little doubt that the term was of a generic nature and signified either a bard or a musician; even the distinct offices of the poet and the musician being known by one name. The opinions of Giraldus Cambrensis seem only to show that the Scots were considered better musi-

cians than the Irish. In truth, all the evidence respecting music that can be obtained from those who were not musicians, is of no value. Cicero has long since told us, that those who will talk of music or of mathematics, without understanding these sciences, must necessarily talk to little purpose. Such opinions may answer the purposes of general history, or may serve for popular currency, but they will not satisfy musicians. The remark in John Major's annals, is unquestionably decisive respecting the existence of a harp with strings of brass; but Buchanan's testimony in this and similar matters, is of no avail. On these subjects, his information is all at second hand, and, like his geography of the Highlands, and his account of their produce and antiquities, is unworthy of attention. But an essay of a very different nature would be required to compare and examine the imperfect evidence of all kinds, external and internal, necessary for the illustration of this subject; instead of the accidental sketch which has here, I scarcely know how, found its way into the account of St. Kilda.

Whatever may be judged the truth on this subject, it appears a remarkable circumstance that the harp should have entirely disappeared from the Highlands for so long a period, when among the Welsh and Irish it has continued in use to this day. It is still more singular that no marks of its existence as the national instrument, more decided and stronger, should remain; when the constant communication between the Irish and the Highlanders at one period is considered, and when even a certain degree of community among the two nations undoubtedly existed.

With respect to the internal evidence on the subject, it appears to militate against this supposition. There is undoubtedly, in many instances, a community of character between the airs of the Irish and the Highlanders; while there are numerous melodies equally claimed by both. Such a joint claim must be expected; yet, in

Ireland, airs of a character derived from the harp predominate, while, in the Highlands, they are rare: among the most ancient they seem altogether wanting. Between the latter and the Welsh, the distance in point of style is much more complete. It is apparent, that in Ireland, and in Wales more particularly, a complete diatonic scale must have been known when the Highlands were still ignorant of it; while it is also evident that these nations possessed a far greater range of scale. Their knowledge of music is thus proved to have been greater; while, by means of chromatic notes, they had also the power of modulating into keys impracticable to the Highlanders. Another character yet, distinguishes these national compositions. In the Highland airs, the adagio movement is common, and the sostenuto occurs every where. In the music of the harp, a sostenuto is impossible; and thus the melodies either assume a more allegro character, or the want of a sustained sound is remedied in the composition, by the substitution of a more florid style of descant on the fundamental notes of the melody. Admitting the general existence of the harp at a remote period, it would still appear from these circumstances, that a more ancient and imperfect instrument had laid the foundation of the style, and that the harp, like the voice, and like the violin in later times, had followed. Exceptions to a certain extent may easily be admitted even on this supposition; and thus may have originated in the Highlands, those airs which are more particularly characteristic of the harp, and which have been referred to Ireland. Even if the true origin of the scale of five notes has not thus been traced to its source in this country; even if it should be conceived, like the scale of the Chinese and the Javanese, to be derived from some more distant fountain, or to be founded in nature, and thus to have been the cause, not the consequence of mechanical construction in the instruments, it will not affect the following reasoning which attempts to derive

from the Highland music the whole system of the melodies of Scotland.

To the peculiar limited powers of the bagpipe therefore, must probably be referred the singularities which characterize the national melodies of the Highlands. On that instrument they appear to have been first composed, and by that has been formed the peculiar style which the voice has imitated, and which the additional powers of more improved and perfect instruments, have altered without obliterating. In no instance indeed has the human voice appeared to lead the way in uttering a melody, or the ear in conceiving one. They follow at a distance that which was originally dictated by the mechanical powers and construction of the instruments which have been successively invented. Hence also an additional proof of the artificial nature of music. The foundation having once been given, endless combinations have doubtless resulted from a delicate sensibility and from the powers of a creative imagination; but the habits of association with respect to sounds, and the pleasures arising from the consonance or succession of notes, appear to have been derived from habits originally founded on mathematical division and on mechanical construction. There is no period in the progress of musical composition in which evidences of this are not to be observed. The notes of the New Zealander's voice are as limited as those of the drum or nasal flute from which they are borrowed. The enharmonic ears of the Greeks appear to have been formed by the peculiar structure of their lyres and flutes; and thus their music acquired a character in which ears accustomed to a diatonic scale can discover no relation of sounds: while even those who, in more recent times, have wandered through all the range of the chromatic scale, are still compelled to limit within very narrow bounds their enharmonic chords. As the original organ gave rise to the plain chant of the early ecclesiastical melodies, so the modern introduction of the violin and other instruments, of more accurate intonation, and of greater volu-

bility and range, have taught the voice powers of which it was not before conscious. The same reasoning may be applied to instrumental composition; as the ear does not ever appear to have conceived any system of harmony or melody which was not previously suggested, at least in its general principles, by the capacity and powers of the instruments in use, or by greater acquisitions of experience respecting their capabilities. Even in the most recent times, the fuller introduction of wind instruments, and the additional powers and effects thence gained, has produced, in the hands of the German school, a revolution in music, undreamt of by their preceptors of the Italian.

It is a much less easy task to deduce from this Highland source, the system of the national melody of Scotland, and to trace the progress of musical refinement downwards to a later period, namely, that of the pastoral, pathetic, or cheerful style of the more modern Scottish airs; while it is also a more delicate subject, as it is in danger of clashing with long established opinions, and with the prejudices of those who confound the pleasures derived from early habit, from association, and from the ideas excited by the poetry, with those which are proper to the melodies only, considered as musical compositions and independently of the exquisite words so often attached to them. Yet on tracing from the rudest to the most refined specimens of real Scottish melodies, freed from the innumerable recent specimens which have been interpolated in the list, it does not appear difficult to observe the gradual progress of refinement from the simplest Gaelic air to the most perfect compositions of genuine character. If this should be established, it is to the Highlanders, or to the most ancient Caledonians, that the foundation of Scottish melody must be attributed, however much improved by the ideas suggested from more recent and better schools of music; although it must still be admitted that this peculiarity of character is often lost, even in compositions of which the origin cannot be ascertained, and which may possibly be somewhat distant. The

pathetic and the lively, the pastoral airs of the Tweed, and even the melodies of the border, would thus equally appear to have been originally founded on the bagpipe. The truth of that opinion will be confirmed by an analysis of these airs; in which the same scale exists, and which consist of the same set of musical phrases under slight modifications. It will often indeed be found, as already remarked respecting the ancient melodies themselves, that the same air which is now known as a Lowland pathetic composition, is also a Highland dancing tune; and so common is this diversity of application of any single melody, that it is now impossible to conjecture whether, in the hands of the original composer, such an air was intended to convey the idea of joy or sorrow; whether it was originally united to words of a pathetic or of a humourous cast. Association is, in this case, every thing; musical expression, abstractedly considered, appearing to be often of so vague a character, as to be readily convertible by mere alteration in the rapidity of the performance; and still more readily, like the sense-echoing sounds of verse, capable of adapting itself to the meaning of the associated words.

From the same cause to which is owing the peculiar expression of the Scottish airs, arise also their defects; the imperfect nature of their scale rendering them incapable of receiving a regular harmony, or of admitting any variety of accompaniment consistently with the rules of good composition. At the same time, they frequently offend a modern ear by their unwarrantable transitions, by the imperfection of their closes, and by the illegitimate succession of implied chords which occasionally occur in their melodies.

In attempting to apply these general principles to the present extensive catalogue of airs ranked in the national list, numerous exceptions unavoidably arise. But an air is not proved to be national, by being placed in a national list; nor is it now possible, amid the innumerable compositions of a mixed, or of no character, which have

been ranked among the melodies of Scotland, to purify that list in such a manner, or so to class the several airs, as to render the subject clear. To a great extent it may however be done, and in executing that task, it is neither difficult to trace the genuine character in the far greater number of those of acknowledged antiquity, nor to perceive the progress by which they have been gradually refined and altered from the simple Gaelic melodies. The causes already mentioned, namely, the introduction of the violin, and the acquisition of ideas introduced from a more refined cast of music, together with the increased use of keyed instruments, have all contributed to modify their character; often indeed nearly to its extinction. Thus a more florid melody has sometimes been engrafted on the original phrases, occasional passing notes have been introduced, illegitimate transitions have been suppressed or modified, and additional parts have been supplied: even the system of the air has sometimes been totally changed, and, on the foundation of a few of the most characteristic passages, a new one of a more refined character has been constructed. In the hands of taste and education they have often thus been improved, even when their character has been in a great measure lost. In other cases, illegitimate and incongruous compounds have been formed between them and those melodies of a more modern school which have long been the common property of all musicians; while in an hundred other instances, the flimsy compositions of no style, which have been generated in the English theatre and in Vauxhall, (fertile sources of bad taste,) have been introduced among them, to the confusion of all character and the reproach of the catalogue. Unfortunately, musical knowledge and taste is not widely diffused through Scotland; and thus, while innumerable worthless compositions have been adopted, simply from being introduced under the name of a Scottish air, many of the ancient and characteristic melodies have fallen into oblivion. It is difficult for those who are not in the habit of analyzing their sen-

sations, to discriminate between the effects of a simple impression, and those arising from association; nor would it be easy to persuade a strenuous admirer of all that is called Scottish music, that his admiration is indiscriminate, and is derived from prejudices and early associations rather than from a distinct feeling of the beauty of that which he esteems the perfection of music. In many instances, it is founded rather on the poetry than on the music; and, by aid of the exquisite verse so often attached to them, have many of these compositions attained a celebrity to which their own merits do not appear to entitle them. In this respect however, with some good, much harm has also been done by modern innovators; who, regardless of the characters long consecrated by habit and association, or of those belonging to the very essence of the melody, have, with an utter disregard of taste, united the pathetic with the ludicrous, or the reverse; or have, with the rude airs of the mountain glen or the careless lilt of the shepherd boy, associated the Delias and Strephons of modern pastoral, or the refined verse of our more recent lyric poets. Burns alone appears to have combined the true feelings of a Scottish musician with those of a Scottish poet; and, had he been an educated musician, would have doubtless, not only refined and separated the true from the false, but, had time been granted him, completed that pure association between the two, of which he has left such admirable specimens. The adaptations of his own lyrics to the airs of his early affections, present a model for all Scottish musicians, as his poetry offers examples that will not easily be rivalled.

To illustrate these remarks by a corresponding analysis of the present extensive catalogue of Scottish music, would require a volume of musical criticism: it is even impossible to notice a few of the airs which would be required to explain them, without a species of illustration which is here inadmissible. It is nevertheless easy to perceive, as already suggested, that many of the Scottish airs of supposed Lowland origin are, in fact, Gaelic

airs of much higher antiquity; altered and improved by the introduction of passing notes, by slight deviations to a more florid style, by the addition of a second strain pursuing the same idea a little further, or by occasional changes of the harmonic basis of the melody still more important. Others are original in every respect, but formed on the same system; while many bear the marks of additional refinement, borrowed, either from the Italian style of ballad, or from other compositions of a similar character which happened to prevail at the time they were written. Musicians who may be inclined to examine this subject, will find little difficulty in doing it for themselves; with a few exceptions, the internal evidence is of such a nature that it cannot easily be mistaken.

I am aware that the preceding opinions are at variance with a notion which has prevailed respecting the origin of the Scottish pastoral music. It has been supposed to have been introduced by James the First: the claims of Rizzio having been for some time abandoned. But in tracing the airs in their gradual progress to refinement, there is no indication of a chasm in their style: certainly at least, none of so distant a date. Still less can any distant period be discovered in which a new style of melody, or any decided and complete change in the character of the national music, was introduced. A few compositions of ancient date undoubtedly exist, which, compared with the prevailing airs of the same day, are evidently of a superior character; but these are exceptions, and have not generated a style. They may have been the occasional productions of individuals who had cultivated a better class of music; possibly some of them have even been the composition of that monarch; and it is not improbable that, like others, he may have contributed to the refinement of the national taste. But that which at present is peculiarly esteemed the pastoral style, seems to have originated chiefly in the last century; partly from

the remodelling of ancient melodies, partly from additional compositions: and among the new airs of this character, the compositions of Oswald, and not those of James, appear to have led the way to the most material innovation in Scottish music which can be established. The claims of that king appear to rest on a misapprehended passage in Tassoni, which Dr. Burney has shown to prove nothing; as he has also shown that the compositions of the Prince of Venosa, with whom James is compared, are worthless. The remark is evidently the casual observation of a mere literary man on a subject which he did not understand. There is, independently of this, internal evidence against the opinion, in examining the progress of the national melodies; against which such vague testimony would be unavailing, did it even proceed from a more competent judge, and had it been of a more decided nature. It is obvions that the limited scale of five notes extended far below this period; and that no airs of that date, composed on a perfect scale, can be produced; although it was then generally known to musicians. James was a cultivated musician, and had he introduced a change, or had he been the inventor of a "new and plaintive species of melody," it would have left traces of that improvement in music which had then taken place over Europe, and of which assuredly none are to be found in the Scottish compositions of that age.

The preservation of a national melody is always desirable, were it only for the innumerable relics of poetry, often of exquisite simplicity and beauty, which are thus rescued from oblivion. It is desirable also, on account of the numerous associations of a patriotic nature, and the social or generous feelings, which are thus excited and preserved. If the faults of excessive nationality are perpetuated and encouraged by a national melody, so also are its good effects. Even abstractedly considered, it is valuable in the art of music; as a store of combinations, and as offering hints, even where it is at variance with

a predominant or more refined taste. The highest departments of art are often indebted to the lowest for useful or valuable suggestions. Independently of these considerations, it is impossible to refuse praise to the melodies of Scotland. They are often exquisitely pathetic and touching, even when separated from the poetry with which they are so frequently united. In the humourous style they excel perhaps even more. Though faulty with regard to that which is now esteemed correct in composition, and though monotonous, from the innumerable repetitions and the limited variety necessarily implied in their scale, they are not perhaps exceeded in merit by any national compositions of an age equally unrefined. It is only to be regretted that those whose musical education renders them competent judges of the subject, do not lend their assistance to maintain these relics of antiquity in a state of purity; and to preserve and restore the national taste, instead of suffering it to be regulated by those whose want of feeling or understanding tends rather to deprave it. If Scottish melody is distinct from cultivated music, it still possesses a character worthy of being preserved; and is in much more danger from the ignorant than from the educated musician.

But the nation at large has little considered the subject of music, nor has it hitherto been much cultivated as an art in this country. Neither the principles on which it is founded have been studied, nor its history and progress traced, from the rudest efforts, towards that limit of perfection which is probably yet distant. It is not however peculiar to the Scots to forget, that although the term music, like poetry, may have a meaning which every one limits to his own capacity for acquirements, the former, like the latter, is unlimited in its powers of expression; and that cultivation is equally required to comprehend the higher departments of both. Under these circumstances, it is not surprising if the Scots

not investigated the peculiarities by which their own melodies are distinguished, nor been careful in separating from their airs of genuine feeling and character, all the modern imitations, of spurious origin, and of common place ideas, which have sullied their catalogue. There is indeed much merit in many, even of the most recent compositions of a pastoral or pathetic character; although few, if any, of modern origin, have imitated the peculiar raciness of the cheerful airs. The former have sometimes successfully maintained the style and feeling of their originals, and have not even been unsuccessful in engrafting on them those melodies of foreign growth most consistent with their characters.

The praise of Scottish music must, however, be limited. Even Caledonian prejudice must recollect, that in music, as in poetry, there is a cultivated style. As he, whose acquirements in poetical taste are confined to Chevy chase, must not doubt the superior feeling of him who is sensible of the beauties of Milton or Pindar, so ought they, whose knowledge of music is limited to Roy's wife or Tweed side, to recollect, that in this art also, there is a standard of taste; and that the vigour of Handel and the variety of Beethoven are beyond the sphere of their comprehension.

THE peculiarly unconnected situation of St. Kilda would have rendered it desirable to know the number and names of all the plants which grow on it; but my time unfortunately did not permit a full examination. No rare plants were observed. The Leontodon autumnale is the only one which can lay the slightest claim to this character; and the botanical catalogue appeared indeed to be extremely meagre. Juncus sylvaticus is among the most conspicuous, covering the cliffs with its bright green leaves; but this plant is common in the exposed Highland moun-

tains. Cochlearia vulgaris and Matricaria maritima, both of an enormous size, also abound among the rocks wherever they can find a lodgment.

Much has been, and is still said, even in the neighbouring islands and among those who navigate the western coasts of Scotland, respecting the difficulty of landing in St. Kilda. As this question is interesting to those who may incline to visit the island, I shall briefly state the circumstances respecting its hydrography, which are most necessary to be known. There is the greater inducement to this, as no account of them is given in any sea chart. Many have doubtless been thus prevented from attempting this voyage; and it was with much difficulty that I could induce the master of the vessel in which I sailed to approach within three leagues of the land. Experience of the exaggeration which so often attends these difficulties had produced a habit of neglecting such reports, which the knowledge of St. Kilda has tended to confirm.

The intricacy of the sound of Harris is such that it cannot be navigated without an experienced pilot, who may always be procured at Loch Maddy or Rowdill. From this to St. Kilda the distance is about seventeen leagues. As the landing is rendered difficult or impracticable in easterly and southerly winds, a fair wind is not desirable for the voyage.

Borera with its accompanying rocks, is much too conspicuous to be a cause of any other dread to mariners than that which would arise from St. Kilda itself in the same case; namely, the difficulty of ascertaining its proximity in thick weather. The high rock Levenish is also sufficiently conspicuous, since it exceeds an hundred feet in height; while it forms an excellent mark for a low rock situated very near and barely covered at high water. Excepting this rock, the whole shore is so clean, that vessels of any draught may range it within bowshot; the water being every where of great depth and the cliffs nearly perpendicular. The stream of tide is here too so

inconsiderable that there is little danger from calms, provided that a very moderate offing is secured. On the south-east side of the island is situated the village, under shelter of a long hill which reaches to a great height and wards off the effects of all winds from the north-east to the south-west. The same ridge shelters the harbour, which is of a semicircular form; advancing, on each side, at least half a mile into the sea, and forming its boundary. The breadth of this bay at the entrance is equal to its depth; and as it opens exactly to the south-east, it is evidently exposed to very few winds, and those not from the predominant points. There is good clean holding ground within the bay, in a depth ranging from four to seven fathoms, where a vessel of any size may lie for a tide or more, with fully as great security as in most ordinary harbours; while there is at the same time no difficulty in weighing and running to sea on either tack, should the wind shift so as to blow in shore. In moderate weather, unless there is a sea from the east, a boat can easily land on the smooth shelving rocks near the village, the activity of the natives always ensuring her from being washed back by the second surge. The position and depth of the bay must also render it apparent, that although there should be a westerly swell, as is generally the case, it cannot be very great on a shore so embayed, unless when it has risen to a considerable degree. The truth is, that seamen, impressed with a false notion of the dangers of St. Kilda, shun its coast when they might often find a convenient temporary refuge in its harbour; to them indeed unknown.*

* An instance of great inconvenience from this cause occurred not long before my visit, in the case of a merchant vessel from the West Indies. The crew had been for three weeks on short allowance of water, and this island was the first land that was made. Here they were becalmed for two days and nearly perishing with thirst; but there being a considerable swell, they would not venture their boat within a mile of the shore, when a landing might probably have been effected with the greatest ease.

This bay is not the only place of refuge. On the north-west side of the island there is also an anchorage, with smooth water in a south or east wind, and with the same facility of running to sea. A boat can also land here on the low rocks which skirt this part of the island. The imperfect map which accompanies this description will convey a sufficiently correct idea of the circumstances now described. I may add that it is high water at St. Kilda when the moon is south-east, and that the course of the flood is northerly. These remarks, slight as they are, may perhaps serve to facilitate the pursuits of those who have been desirous of visiting this spot, but have been deterred from it by the causes already mentioned.

As there is no nautical survey, so there is no map of this island better than Macaulay's, which is palpably erroneous; nor is there any measurement of it on record. Martin's computation of its dimensions is far too low. I was unable to do more towards supplying this defect than to sketch the form and conjecture the size, by walking over it with the assistance of a pocket compass. The altitude was determined by the barometer. Its length appeared by this estimate to be about three miles and its breadth where widest two. I may add that this sketch was merely intended for geological reference.

Within the bay at the south-east side, the land falls by a steep declivity to the sea; part of it terminating in a sandy and stony beach, and the remainder in those flat shelving rocks which form the landing-place.

The eastern boundary of this bay, which is the high hill before mentioned, terminates by precipices, at first of a moderate elevation; but they gradually rise in proceeding round the point, until they nearly equal the highest summit of the island. This is the conical point called Conochan, which overlooks the bay, its height being 1380*

* Macaulay says that he measured the height of Conochan and found it 900 fathoms, (5400 feet): he calls it the Teneriffe of Britain. Even

feet above the level of the sea below. Not many yards beneath this summit the hill is cut almost abruptly down to the water; a dizzy height to the spectator who looks down upon the almost inaudible waves dashing below. At the foot of this fearful precipice some lower rocky points project; which, in any other situation would attract notice, but are lost in the overpowering vicinity of the cliffs that tower above them. The northernmost is perforated by a natural arch of great beauty, and of considerable grandeur; but the western ocean is unfortunately seldom free from a swell sufficient to prevent boats from approaching it. In proceeding to the north-west, the shores soon become considerably lower; while the land subsiding by a steep grassy slope, forms a kind of valley along the sinuosity which here looks towards the north. Near the extreme point of the island it again rises into a hill almost equal in height to Conochan and terminating all round towards the sea by precipices. Hence to the southern extremity, a continuous precipitous fall bounds the ridge; preserving a high elevation along the western shore, till it terminates in the narrow but high ledge of rocks that forms the southern horn of the bay. This promontory is detached from the island by a fissure through which the sea flows. It is called Dune, and appears to have been once the seat of some rude tower or fortalice.

At the north-western end of the island lies the small but lofty and precipitous Soa, separated from it by a narrow strait in which are two highly picturesque rocks; one of them being perforated by an arched passage. The depth and darkness of this narrow chasm, form, when viewed from above, a scene of singular sublimity, particularly in stormy weather; the clouds which sweep along the summit involving the spectator, and the mists which arise below from the dashing of the sea, adding

habitual inaccuracy in matters of ordinary occurrence, can scarcely account for such errors in things that are to be determined by weight and measure; but they are not confined to Macaulay.

indefinite dimensions to the already tremendous depth. The scenery of St. Kilda presents objects of this class only. A dizzy height from which the eye looks down over jutting crags retiring in succession, while the sea below appears, from the invisible nature of its boundary, removed to an undeterminable distance; or dark cliffs beaten by the unceasing surge and lost in the gloom of the clouds that hang on them, are not in the strict sense of the term picturesque. They are of a higher order, and beyond the narrow limits of art. Its powers cannot reach these sources of the sublime in landscape; since the laws of perspective prevent the effectual use of the first class of objects, while the unavoidable reduction of that extensive scale which is the chief cause of the powerful effect of simple forms, is destructive of the grandeur of the latter.

At a distance, the outline of St. Kilda is neither sufficiently elevated nor varied to produce subjects for the painter. Yet in the accidental circumstances of light, of changing clouds, and of a restless sea, and among the endless effects which result from the constant variations of these objects, he will find studies for the higher departments of his art such as are rarely to be seen in the more accessible islands of this sea. The cause of these more frequent and striking effects, is to be found in the detached position of this island and that of its neighbour Borera. They are the only objects capable of affecting the courses of the clouds in this open sea; and they are accordingly often involved in mists and showers, and blackened by dark shadows, when the rest of the atmosphere is settled and clear. It is here easy to observe the power which land possesses of precipitating clouds from a transparent atmosphere; an instructive phenomenon occasionally to be seen in other situations, and formerly noticed in Rum.

Different caves and arches, besides that already mentioned, are to be seen along these cliffs. In front of

the harbour is the fine rock Levenish, already mentioned, presenting a striking feature on approaching the island. In a northerly direction is seen the very picturesque island Borera with its two remarkable accompanying rocks Stack Lii and Stack an armin. It appears to be about the height of St. Kilda, but is seldom accessible; having no sheltered landing-place and being precipitous all round. The weather did not permit me to approach it. Like Soa, it maintains a proportion of sheep, which few but the inhabitants of St. Kilda could either place there or remove, and is also the resort of innumerable birds.*

The geological history of St. Kilda may be contained within a very narrow space, yet is not without interest.

The rocks all belong to the trap family, using that term in its most extensive sense so as to include syenite. It will be shown in the course of this work, that almost all the rocks of this class which occur in the Western islands, are found above the secondary strata, and are therefore of comparatively recent origin: but as no stratified rocks, whether primary or secondary, can be discovered in St. Kilda, we have here no criterion by which to judge either of their date or connexions.

Conochan, the highest summit, is formed entirely of that syenite already described as occurring in Sky, in

* These islands are the favourite resort of gannets. No disturbance ever appears sufficient to induce these, more than the other species of sea fowl, to change their haunts, nor do they court uninhabited places in particular. In leaving St. Kilda in an evening they are met flying home in long flocks, separated widely from each other and apparently each under its separate leader. At seventy miles from the island they were all found directing their course to it. It is imagined by the seamen and fishermen of this coast, that they fly out in the morning to feed, even to the southern parts of Britain, and return in the evening; a circumstance not improbable, when the strength and rapidity of their flight is considered.

Mull, and in Rum. It is composed of compact felspar, varying in colour between yellowish, reddish, and brownish grey; with a very slight intermixture of hornblende, and, occasionally, of quartz. At times it assumes a vague porphyritic character, and on other occasions undergoes further variations of aspect which it is unnecessary to describe, as similar circumstances have been sufficiently noticed in treating of the preceding islands. Extending from the summit of Conochan, it includes the whole of the hill which constitutes the northern boundary of the harbour, descending to the shore in those flat beds already described as the landing-place for boats. It has here, indeed, as is not unusual elsewhere, a tendency to the bedded disposition; the beds being commonly straight and, like granite, divided into huge rectangular masses. A few caves occur in it on the shore, and it is traversed near the bay by two long and nearly horizontal basaltic veins at no great distance from each other, the fragment of a third being also seen near the village: these appear to be about ten feet in thickness. The cliffs formed by this rock are in most places mural in the strict sense of the word; defying the climbing powers of the natives as well as the lodgment of the sea fowl. I may add that Levenish is also composed of this substance.

This syenite occasionally presents cavities containing regular crystals of transparent smoky quartz, as well as obscure and imperfect crystallizations of felspar. I perceived none of a large size; but Martin, whom, on subjects of this nature, there is no reason to doubt, describes crystals of brown quartz two inches in length as found in it. This is the only instance in which I have observed the constituents of syenite thus crystallized, and like the micaceous variety formerly described in Sky, it presents an example of the near affinity between this substance and granite. Its resemblance indeed to certain specimens of the granite of Arran is very remarkable;

the rude crystallizations of felspar and the smoky quartz being also prevalent in the latter rock.

The remaining, and by far the larger part of the island, is composed of a dark trap rock. I can only pretend to describe such varieties as are observed on the surface of the land; since it is impossible, either from sea or land, to approach the cliffs so near as to form any judgment of the different modifications they may contain. They are all however obviously composed of this substance; and I may add that no columnar forms were apparent, but that some portions seemed to indicate that looseness of texture which belongs to the amygdaloidal varieties. The specimens visible on the surface present generally the character of a greenstone, abounding in hornblende and often passing into basalt. A dark lead-grey compact felspar with little or no hornblende, is also occasionally found. In many situations, the rock contains large concretions of the latter mineral; which are as usual much more distinct on the weathered surfaces than in the internal fracture. They assume at times a singularly serpentine or reticulated disposition, and at others, appear like the heads of nails driven into the surface. Augit also forms in some places an integrant part of this rock, and it is perhaps sometimes this substance which I have here called hornblende; but the difficulty of distinguishing these minerals, when they are found in an intimate state of mixture, is very great.

The trap thus described is not disposed in terraces, nor has its fracture on the great scale the vertical tendency which that rock so commonly assumes. It is spiry and irregular, and thus produces the craggy uneven surface on which the sea fowls breed; the broken fragments and soil accumulating in various places so as to form small grassy slopes.

As far as the relations of the trap and the syenite can here be ascertained, by a distant view of these high cliffs from the turbulent sea below, or from a perilous

station on the overhanging precipices, they appear to join each other in an obliquely vertical direction. The deep covering of grass and soil on the surface, prevents that junction from being seen where it would otherwise be accessible. The general boundary of both can however be partially traced, by means of single rocks protruding at the surface, and by the distinct nature of the fragments which occupy approximate regions on the slopes of the hills. This line lies between the north-west and south-east points, leaving the town and the hill of Conochan on one side, and nearly intersecting the middle of the bay. The syenite is on the east side of this line and the trap on the west.

Where this boundary lies, numerous fragments of trap penetrated by veins of syenite are found: these have probably been detached from the line of junction, and they present the only actual contact between the two substances which admits of a close examination.

It will be recollected that both in Mull and Rum there is distinct evidence of the transition of the trap and the syenite into each other, proving that they belong to a common deposit. There is probably the same community of origin in St. Kilda; however difficult it may be to account for the complete and somewhat sudden change of character between these two portions. It will indeed appear, that in the cases which occur in these islands, where syenite and trap exist together, three out of the four present indications of a common origin; and that nothing to contradict that rule is discovered in Sky. It is probable that it will be found to hold there also, and that the examples will be discovered in those parts of the mountainous region which are so difficult of access. The appearance of veins passing from the syenite into the trap, is the only circumstance in which the junction of St. Kilda differs from those formerly described, and it might seem at first view to afford an argument in support of the posteriority of the syenite. But it will I believe

be found, that these are not real veins. A similar appearance occurs in Arran, and in circumstances which preclude all possibility of its arising from the ramification of one rock into another. It seems a variety of that concretionary structure which is known to occur under other forms, in this rock as well as in granite.

As the state of the weather did not permit me to approach near to Borera, I can only conjecture, from its form and colour, that it consists entirely of trap, as I observed no indication of the peculiar disposition which attends the syenite.

Such is the mineral history of St. Kilda, solitary in structure as it is in position; since the nearest rocks on the east side consist of gneiss, and the first we meet with on the west, Rockall, is formed of granite.

GENERAL COMPARISON OF THE TRAP ISLANDS.*

It will now be convenient, for the purpose of general scientific views, to bring into one collective statement the leading particulars in the structure of the islands of this group, as far as they possess any relations to each other. Thus, those local details, of which the interest would otherwise be limited to a narrow space, become of importance by their mutual dependence; and such a continuity of structure is thus by inference restored, as would follow, either by replacing the portions that seem to have disappeared from among these islands, or by removing the obstacles which cause the present semblance of discontinuity where, in a geological sense, it may not actually exist. In attempting thus to bring the whole under one general view, it will be necessary to recapitulate many particulars; but the unavoidable repetition occasionally arising from this, will be compensated to the reader by the greater facility that will thus be afforded to him in understanding their connexions, than if he had been suffered to draw the comparisons for himself.

Notwithstanding the set of common characters by which the whole group of the Trap isles is united, there is one common feature existing in Sky and the neighbouring islands, in which Mull can scarcely be said to participate; while that portion of the group is also associated by a certain intimacy of geographical position, from which this island is in a great degree excluded. The connexions of the former subdivision with the continent, are also formed by the primary strata solely; while those of Mull with the adjoining land, are to be traced chiefly in the secondary, and in the masses of trap which cover them. A corre-

* See the general Map.

sponding arrangement will be necessary in drawing these comparisons; those which relate to Mull being reserved to the last place. It may be added that the remote situation and apparently unconnected condition of St. Kilda, excludes it from this general view, and that no notice is taken of the smaller isles which, like Staffa, contain no stratified rocks, and therefore admit of no useful comparison. The comparison of the unstratified rocks is indeed always so unsatisfactory, from the want of definite characters by which to judge of their relative ages and original connexion, that this view must be chiefly limited to the stratified substances.

Wherever the continuity of the stratified rocks is, as in this case, interrupted, any judgment respecting their identity must be derived, partly from the correspondences of the bearings and inclinations, and partly from similarity of composition. Circumstances which do not at present admit of a remedy, throw an occasional shade of doubt over the accuracy of the former class of observations, without however destroying the evidence they are calculated to afford.

The principal of these consists in the imperfections of the maps on which the rocks have been unavoidably delineated. These imperfections exist, not merely in the outlines or dimensions of the land, but in its bearings, or in the directions which the several coasts and islands possess towards each other. Owing to the former, it has sometimes been impossible to lay down rocks in their ascertained bearings; because, after they were determined, no room for them was found without falsifying their positions or altering the map; while, in many cases, the erroneous positions given to the land, have led to the distortion of a line of strata in the draught, where it had been found in nature to be perfectly even. The most remarkable of these errors have occasionally been corrected, but they cannot be effectually removed until the accomplishment of a new survey.

Two other kinds of error will be found to interfere with the correct determination of the directions of the strata. The first of these arises from an undulation of the line of bearing, which although sufficiently constant where a large space is assumed, with certain decided exceptions that will here appear, is found to vacillate within certain limits; rarely amounting to a point of the compass, and never exceeding two. The second cause of error, is an uncertainty arising from the unequal variations of the magnetic needle. With a sufficient degree of labour and time it might have been possible to determine that variation at every point; as well as the actual deviations of the bearings and dips, all of which have been noted in a general manner. But such observations, could they even be perfected, are of no value unless they conduce to some general object. That for which they have, both here and elsewhere, been brought into notice, will be as effectually accomplished by taking them within the limits of error now acknowledged, as if every dip and bearing had been determined to a degree. In laying down the bearings, the variation of the needle has every where been assumed at 23° west; although this, as I formerly remarked, is by no means a rate universally applicable.

In the tract which includes the northern division of the Trap isles, there are examples both of the primary and secondary strata; the former being limited to gneiss and primary sandstone, using these terms in a comprehensive sense, the latter including a limestone, here distinguished by the name of gryphite limestone, and a set of strata which may, without much risk of error, be classed with the lias and those arenaceous rocks that immediately follow it.

It has been fully shown that both the gneiss and the red sandstone of Sky are prolonged in a north-easterly direction to the mainland, with which they are therefore connected on this line of their bearing. They are moreover connected with the same strata by a system of alternation;

the sandstone being repeated near Eilan reoch after an interval formed by the gneiss of Sleat; and that portion of it which is prolonged to Loch Alsh, being found regularly alternating with the gneiss of that district.

The connexions of the primary sandstone of the several islands immediately in the vicinity of Sky, with that island, with each other, and with the mainland, have also been amply detailed, and it has been further shown that this rock is prolonged to Rum, where it must be supposed to terminate, since the prolongations of the strata meet with the gneiss of Tirey and Coll. Whatever variations may occur in these lines of bearing, they are not often considerable, but must rather be considered as examples of that undulation from which strata are seldom exempt. In Rasay alone, it was seen that an essential change of direction took place; and it may be remarked that on the adjoining shores of Applecross the same change occurs; the sandstone here assuming a different position, which is maintained for a great space. The dips of the gneiss present a general uniformity, but those of the sandstone undergo material variations; which however are analogous to those irregularities that characterize it on the adjoining continent. That rock will be shortly described at some length in treating of the Sandstone islands. It is only necessary here to remark, in anticipation, that no doubt can exist respecting the geological connexion of all these masses of sandstone, though interruptedly scattered among the several islands; nor that it appertains to the primary class of rocks; often alternating with the gneiss on which, in other places, it lies.

In examining the secondary strata, the first in order is the gryphite limestone, the connexions of which have been so fully traced in the islands in which it occurs, that it is unnecessary here to dwell on them. It is only necessary to remark, that as the leading direction of this limestone in Sky is north-easterly, it ought, if continued, to appear in Rum. As it does not exist there, it is probably

disposed in an irregular cavity resembling that which has been termed a basin; examples of which are of frequent occurrence among the secondary rocks.* That conclusion may perhaps be also deduced from its absence in Rasay, where the same shale and calcareous sandstone that follow the lias in Sky, appear to repose immediately on the red sandstone. Yet even this appearance admits of another explanation; since the gryphite limestone may, even in Rasay, lie beneath the uppermost strata, although the immediate contact of these with the red sandstone only, should be visible. This solution depends on the mode of arrangement of the strata in basin-shaped formations; and as it cannot be rendered easily intelligible in words I have added a section for its illustration :† the basin in this case will be common both to the gryphite limestone and the strata that follow. The view formerly presented in Scalpa, of its probable division into separate cavities on the irregular surface of the sandstone, will tend to illustrate and confirm this explanation.

The last of the secondary strata, are those which follow the gryphite limestone, which I have referred to the lias series, and to those strata which, in other situations, are known to succeed it. The state of dispersion in which these are generally here found, prevents, in almost every place, any other comparison than that which may be founded on their similarity of composition and on the resemblance of the organic remains they contain. In describing Sky and Rasay, I have been already obliged to draw this comparison as far as these two islands are concerned, and I need not therefore recur to it. In the case of the other islands it was more slightly touched on. The occurrence of the lias among these islands, will probably however be considered an interesting circumstance; since

* Although this limestone should be considered a portion of the lias series, it will not affect this reasoning, which would be equally applicable to it as the lowest bed of that deposit.

† Plate XXIII. fig. 4.

the knowledge of that rock acquired by English geologists, in consequence of its predominance in the southern parts of Britain, has not only served to ascertain its discriminating characters, and to determine its connexions and extent in this country, but has enabled them to trace it in other places, under circumstances of more general interest.

It will be remembered, that in the Shiant isles there is found a shale containing belemnites and lying immediately under the trap; and that in the same islands, thick beds of grey shale occur together with beds of siliceous schistus; the circumstances under which the latter rock is found being the same as those under which it appears in Sky. There is in this case as exact a correspondence between the two sets of strata as could be expected under similar circumstances; and it is therefore reasonable to conclude, that the stratified parts of these islands are either detached portions of the same strata which in Sky accompany the lias, or are still connected with these beneath the sea.

There is even a nearer correspondence between the spheroidal sandstone of Egg with its accompanying strata, and the upper series of Sky; a similar general succession occurring, though under slight modifications; while the organic remains of both, with the particular stratum in which these lie, and which I have in Sky shown to be the upper portions of the lias, are perfectly identical. The rocks which ought to be found below these, are here also invisible; partly from the interference of the trap, and partly from the position of the strata as they relate to the level of the sea; for which reason the comparison must be limited to the instances here adduced; the proofs of identity being sufficient to establish the continuity of the lias formation at least. The same reasoning may be extended to Muck, although the portion of strata found there is so limited in extent and accessible to so small a depth; the limestones of that island being in every

respect similar to the pale coloured and uppermost strata of this series.

In concluding these observations on the geographical relation of the fragments of these strata, it is proper to remark, that no traces of them are found on the continent immediately adjoining Sky. But in Loch Greinord, far to the northward, two minute and solitary portions occur; highly interesting from their insulated position, and no less so from their possible connexion, in times far distant, with the remainder of these now disjointed fragments.*

The last subject of inquiry is, whether these several portions are, as I have here hinted, merely the separated parts of a mass of strata once continuous, or whether they have been originally deposited in distinct cavities. It is possible that the original deposits, of some of these strata at least, have been partial; and that the present resemblances are rather the result of analogy than identity. This question is important, as it involves others of considerable moment respecting the general changes of the earth's surface and the theory of the secondary strata; but the want of satisfactory evidence is such that I can scarcely venture on it. It must probably remain for decision to some future period, unless the following argument in favour of an extended deposit should be deemed satisfactory.

It has been seen, that notwithstanding some partial disturbances, there is a general conformity of position, as well as of character, throughout the whole, wherever the body of strata present is sufficiently considerable to permit these circumstances to be examined. It may therefore be presumed, that this identity bespeaks a continuity once more perfect among the several detached portions; as it is difficult to conceive that such a community of character should have been affected by separate

* This place unfortunately lies out of the limits of the accompanying map. The reader may consult Arrowsmith's Map of Scotland.

deposits scattered in so detached a manner throughout so wide an extent. If this be admitted, it will follow that a great waste and removal of the strata must have been effected before the present fragments could have been separated as they now are found.

Some important general questions here arise respecting the connexion between the trap and the secondary strata, as well as between that rock and the primary; although this latter is of comparatively trivial moment. It must have been apparent, that whether the unstratified rocks which so often accompany and interfere with the strata, are present or not, or whether they are more or less abundant, the general positions of these are in no wise affected, even in cases where the trap is found clearly intersecting them. It follows therefore that the present position of the strata was determined by causes independent of the trap, and prior to its formation. It equally follows, that the disturbances which this substance has caused in the secondary rocks, must have depended on circumstances of a very limited and partial nature; since they are confined to a short distance from those points where it is found either cutting through the strata or sending branches into them.

In the next place, no marks of disturbance are any where visible, of such a nature as to have involved the trap and the stratified rocks in one common movement, or of such posterior displacements as have equally affected both. No signs of general dislocation in short are any where to be seen in the fundamental rocks, that do not appear to have been produced previously to the deposition of the unstratified substances. The trifling disturbances caused by the trap veins are here, of course, excepted. Hence arises the general regularity of the plane of separation between the stratified rocks and the trap; and hence also may be derived the conclusion, that no extensive changes in the disposition of the strata have taken place since the formation of this substance.

The last remark refers to the interval of time which has passed between the deposition of the secondary strata and the period of that formation. That interval cannot indeed be conjectured; but undoubted marks of its existence, though not of its length, are to be found in the same phenomena. It has been shown, that the present disjointed state of the strata is in many cases unconnected with the influence of the trap, and that this rock has, with certain exceptions, accommodated itself to those portions which had been separated by the influence of former causes. Of the nature of the causes which have produced such evident marks of waste on the earth's surface, it is unnecessary to inquire; nor are they within the limits of the proposed investigation. It is sufficient for the present purpose, that changes so considerable must have occupied time; and that some interval, probably great, had elapsed between the period at which they were effected and that at which the trap rocks were superimposed on their scattered remains.

It is now necessary to examine the relations of Mull to the adjoining mainland, and to inquire respecting its connexion with the northern islands of the group in which it has here been placed.

This island offers but few points of general comparison with the preceding, and even less with that part of the continent to which they are nearest. Moreover, the difficulty which there exists in tracing the connexions between the disjointed portions of the primary or secondary strata, encumbered and separated as they are by mountains of trap and other unstratified rocks, exists here in a much greater degree.

The granite of Mull must be considered as an insulated mass; but in this respect it is not peculiar, since that rock occurs under similar circumstances in the neighbouring districts of Strontian and Morven, as well as in many parts of the adjoining continent.

With respect to the primary strata which succeed it,

there can be little doubt that they are detached portions of that formation of gneiss which constitutes the chief part of Morven, with the adjoining district of Ardgowar, and the islands of Tirey, Coll, and Iona. The approach of the strata of Morven to the eastern shore of Mull, may be traced in the southern Glas islands; and it is probable that they pass hence to the opposite side of the island, beneath the sea and the superincumbent trap. If the want of correspondence in the bearings be considered an objection to this view, it must be recollected that similar deviations are not unfrequent, and that there is moreover some uncertainty respecting the real bearings of the primary strata of Mull.

In comparing the detached portions of the secondary rocks of Mull, we must be guided partly by general analogies, and partly by corresponding circumstances in those already examined in the northern Trap islands, and in those which occur in the adjoining continent.

The rocks of this division already described in treating of those islands, are found also in Airdnamurchan and in Morven; and in circumstances which, without the aid of analogy, would lead us to conclude that they followed in the same regular order. As those of Airdnamurchan are however of little value in this comparison, I shall give a sketch of those of Morven only; the correspondence of this tract to Mull being in every respect so perfect as to leave no doubt respecting their geological continuity.*

The far larger portion of this district consists of gneiss, occupying the same north-easterly position which is predominant throughout the western coast of Scotland. No primary sandstone is here found, that rock having terminated to the southward at Glen Elg. The western side of

* Plate XX. fig. 12. In this, as in other similar sections, the proportions are sacrificed to the necessity of bringing all the essential circumstances within moderate bounds. A map of Morven is not within the limits of this work.

the peninsula consists of a mass of trap, the general extent of which (on the shore only) is indicated, for the sake of this comparison, in the map of Mull. Between the trap and the gneiss is found a body of strata, consisting of limestone followed by sandstone, where the series is complete: in other cases, only one of these rocks is present. In a few situations coal also occurs.

The limestone corresponds in every respect to that which is found near Achnacrosh: being of the same composition, and containing the same organic remains. The sandstone also, and the accompanying coal, are similar to those found at Carsaig.

With respect to the position of these strata, they are necessarily regulated by the inclinations of the surface of gneiss on which they are deposited, and they present, in consequence, every variety of dip. Their peculiar situation also, causes the same apparent disjunction that is so remarkable in Mull; since they can only be traced in those places where the common boundary of the trap and the gneiss is exposed to view. This circumstance however, appears here under a form highly interesting, and illustrative of the real structure of that island. Wherever this conterminous line is visible, the strata are found lying between those two rocks, even where the trap occupies insulated portions on the surface of the gneiss. From this it may be concluded that the deposit of the secondary strata is complete, beneath the trap; at least within certain exceptions of interference, or of partial removal, on which it is now unnecessary to dilate.

To transfer this reasoning to Mull, it appears that although these strata cannot there be traced with even the same limited regularity, detached parts of the series are found scattered throughout the island. It has been shown, that limestone containing gryphites, ammonites, and belemnites, is found near Achnacrosh. There is a perfect identity between this rock and the corresponding limestone on the opposite shore of Morven; and although

it is not here succeeded by the sandstone, it must be recollected that this stratum is also frequently wanting in that district.

The limestone of the southern shore is presented in a very unquestionable form, since, as in Morven, it is succeeded by sandstone including coal. Its peculiar characters, and the absence of organic remains, offer no argument against this view of its nature; as in similar circumstances, where trap rocks interfere, the same changes are found to occur in the conchiferous limestones. The occurrence of coal is here peculiarly important, as it identifies these strata with those of Morven, of which this substance forms in many places an integrant, though a small portion.*

The circumstances under which the calcareous sandstone occurs on the western shore of Mull, are such that it is impossible to trace its connexions with the strata of the eastern and southern shores. From this, and from the deficiency of the calcareous strata which ought to follow it in order of subjacence, it might be questioned whether these arenaceous beds were the upper portions of the same set of strata. This is however rendered probable, partly by the identity of their composition with the sandstone of Morven, and partly by the analogy of Rasay; where, in a similar manner, the strata above the lias, which resemble these, are found in contact with the primary rocks; the intermediate members being absent. Should this be the case, it will appear that the limestone has here also, as in Rasay, been extenuated until it has vanished. That conclusion follows from the structure of Inch Kenneth. It has been shown that in

* The situation of this coal in Morven is on certain occasions very remarkable, and capable indeed of startling a geologist nearly as much as a coal surveyor, since it occurs on the summits of primary mountains exceeding 2000 feet in elevation. The explanation of this appearance is easily derived from the preceding statements, and it is also indicated in the accompanying section.

this island a conglomerate and a sandstone, of a red and of a grey colour, lie immediately on the primary strata. There can be no doubt of the analogy of these rocks to the ordinary red sandstone which, in the central parts of Scotland, immediately follows the primary strata; and it is apparent that they are here succeeded in immediate superposition by the white calcareous sandstone. The general conclusions respecting this scattered series will not however be affected, even if the place of the limestone on the western side of Mull and on Inch Kenneth be conceived to lie above the calcareous sandstone, as, in other situations, these substances are known to alternate.

The following general conclusion may be drawn from these facts. The gneiss of Mull and Morven are portions of the same mass of strata, and have originally been covered by a deposit of secondary rocks, consisting of limestone and sandstone with coal occasionally interspersed. The essential characters of this deposit correspond with those of the northern islands, and no less with the more extensive tracts which occupy the centre of Scotland; of which a portion, similarly detached, and strongly corresponding in position and present connexions with this, is still to be found near the Mull of Cantyre, forming the present coal field of Campbelltown. This tract of secondary strata has, both in Mull and in Morven, been overwhelmed by a deposit of trap, of which disjoined portions only, of greater or less magnitude, are still existing. To this rock, and to the consequences of its subsequent partial destruction, is now owing the obscurity which attends these strata; and from its interference in various modes, has in a great measure arisen the present scattered state of their fragments. This case is so parallel to that of Sky, that it requires no further comment; although presenting some very interesting points of difference.

It is now necessary to investigate the connexion between the strata of Mull and those that are found in the northern

division of the Trap islands. Considering the distance between these two portions of the group, it might possibly be doubted whether the secondary strata of Sky and the adjoining islands do not form a separate deposit; yet the circumstances of correspondence are of such a nature as to leave no reasonable doubts on that subject.

Although the geographical connexion among the several parts of the whole group is not intimate, it appears sufficient, with the assistance of the adjoining portions of the mainland, to admit of the geological approximation of the different islands.

The general position and the great extent of the gneiss, renders it probable, in the first place, that the whole are fundamentally connected, partly by means of this rock, and partly by the primary sandstone which accompanies and alternates with it. The last portions of the latter strata to the southward, occur in Rum; as, on the mainland, they reach no further than Glen Elg. This sandstone, as will shortly be seen in the description of the Sandstone islands, and as may be deduced from the general map, is in a great measure limited to a certain space on the north-west coast, its north-westernmost point being found in Lewis, as the southernmost is in Rum: it cannot therefore be known whether Egg and Muck repose on it or on the gneiss: from the prolongations of the continental strata they may be rather conjectured to lie on the latter rock.

With respect to the secondary strata, it has appeared that they are found on the shores of Morven and Airdnamurchan, as well as in many of the islands under review. The connexion between those two tracts is sufficiently obvious in the general agreement of all their rocks; while the identity of the secondary strata of Mull with those of the former is perfect. The resemblance between the calcareous strata of Airdnamurchan and of Muck is also such, as, together with their proximity, to justify the deduction that they are parts of the same general deposit. By this

intermediate point therefore, Mull becomes connected with Egg, and ultimately, with Sky and the remaining islands; and thus the geographical continuity of the whole deposit is in a manner restored. The geological identity of the strata throughout the whole, may be deduced with as little hesitation, from the various points of resemblance between the several beds in the different islands, and, among others, from the correspondence of the organic remains. To the latter proofs, as they may be collected from the various descriptions already given, I may now add, that some of the beds of the Morven limestone contain pectines, and are undistinguishable from those of Scalpa. The identity of those two remote portions of the series is thus established, and the common nature of the whole proved; as far as it is possible in these dislocated regions, to prove any thing respecting the original continuity of the now separated portions. The geologist who has had the good fortune to investigate these rocks in the extensive plains of England where he can trace them for many miles, must excuse him who, in Scotland, is condemned to pursue them with incessant watchfulness, and by the most minute indications, through an intricate and difficult country, if he cannot produce, in confirmation of his views, a mountain, where Nature has only preserved specimens of her former strata.

Considering the identity of the secondary strata throughout these islands as being fully established, it remains next to inquire whether they present marks of any connexion more extensive, or whether they do not rather form a separate deposit; being analogous to others of the same nature, but, in a local view, independent.

It has appeared in the preceding remarks, that both their superior and inferior portions rest on the primary rocks in different places. Inch Kenneth presents the only example of that which has been esteemed the natural termination of this series downwards; and it may therefore be concluded that Mull occupies a position near the border

of this deposit, which thus terminates at the place just mentioned, by a thin edge. In examining the other margins of this mass of strata where they are actually visible, the superior beds are found in contact with the primary rocks, indicating, in those places also, the natural terminations of the secondary rocks, although in a manner less consonant to the ordinary appearances. The very irregular form of this deposit is visible in the peculiar position of the primary strata of Sleat with respect to the whole; but these inferences will more readily be deduced from the general Map than from any verbal description. In most places however, the borders of the strata are invisible; either in consequence of the sea which conceals them, or the trap by which they are covered or obscured; while many portions also have doubtless been removed by those posterior changes so often alluded to.

Notwithstanding these obstacles, there appears reason to conclude that the secondary strata of the Trap islands form one deposit; analogous to those occurring elsewhere, but separated, even from the nearest in Scotland, by an interval so great as not to permit us to conclude that they ever were connected, without assuming revolutions of the surface greater than could be inferred from any evidence we possess on this subject.

One singular circumstance respecting these strata is yet deserving of notice, and is deducible from the structure of Inch Kenneth; the importance of which small spot becomes visible in this general comparison: it was not noticed in describing that island because its consequences could not then have been foreseen by the reader. Although, for the purpose of illustrating Mull, a rigid examination both of Morven and Airdnamurchan was made, no red sandstone was discovered in those districts, nor did it occur in any part of Mull. On the contrary, wherever the secondary strata are accessible in the former part of the mainland, the upper members, consisting of the limestone and white sandstone, are in contact with the

gneiss; and in the latter, limestone alone occurs. Should it even be found in a few partial spots it would only confirm the view to be deduced from its equally partial occurrence in Inch Kenneth. That conclusion is, that this apparently important member of the secondary strata, may occasionally be absent even for a considerable space; and that it is not therefore necessarily the first in order of these rocks. On the contrary, it either occurs in a limited manner, or may be altogether absent. Thus some of the higher members of the secondary strata repose on the primary; and in this particular case they repose immediately on that gneiss which follows the granite. The geological series here, is therefore, granite, gneiss, organic strata with coal; an arrangement which forms a conspicuous exception to the order commonly assumed as prevalent in nature. It is unnecessary now to recapitulate the circumstances in the structure of the northern division of the Trap islands which confirm this view; but the reader cannot fail to recollect, that in those also, no secondary red sandstone occurs; but that the upper members of the secondary strata are found in immediate contact with gneiss and other primary rocks. The extent of this deficiency is therefore considerable; and if it is only by the absolute magnitude of an exception that its value is to be estimated, geologists will not refuse to consider this one as of an important nature.

It is difficult to discover any general principle by which to compare the unstratified rocks. The causes of this difficulty must already have appeared in the observations which have accompanied the descriptions of these masses in the several islands where they occur. Although many different substances are found among them, these are all so blended, and united by such imperceptible gradations, that the posteriority or priority of the one or the other cannot be discovered, even if such differences in relative time should actually exist between them. The difficulty,

in fact consists in the very nature of these rocks, and in the mode in which they were formed, nor is there at present any prospect of resolving it. It is unnecessary to recapitulate the few points which appeared, in some of the islands, to prove that there were marks of difference in the relative ages of some portions of these rocks; as they cannot be placed in a more luminous point of view. Further acquisitions of knowledge on this subject may possibly hereafter diminish or remove these difficulties; and until that period shall arrive, we must unavoidably remain in doubt respecting many important particulars in the history of the trap series. Yet it has appeared from the examination of Canna, that there have been repetitions, in the same place, of successive formations of trap; the distinction being there made by the conglomerates interposed. It will hereafter be seen that, in the Schistose isles, some phenomena occur which appear to prove the same fact; a circumstance which is further supported by the evident repetitions of trap veins in one place, of which Airdnamurchan presents some striking examples. Assuming that to be generally true, it may follow that many of the trap rocks of Sky, as well as of the other islands, are of different ages; that the hypersthene rock of the Cuchullin, for example, differs in time from the syenite and from the stratified traps of the western shore; but proofs to this effect are not to be obtained, nor is it at present easy to conjecture whence they may ultimately be derived. It has on many occasions been here shown, that substances differing greatly in composition were continuous; so that no proof of difference in time is contained in difference of character. It has equally been proved that the connexion of these rocks with the strata, whether primary or secondary, gave no indications of such a distinction in time. In examining the causes of these difficulties, they will be found to consist partly in the mode in which these rocks have been formed, and partly in the period, rela-

tively to the inferior strata, at which they were deposited. The consequences resulting from the former are obvious. From the latter it is apparent that they can bear no fixed relations to the strata; as, independently of the disturbances which they have produced in these, many changes of the surface, and extensive losses of substance, have occurred before their deposition, or at periods intermediate between their several depositions. But it is unnecessary to pursue a subject of this nature.

Under whatever periods of time the trap rocks of these islands may have been formed, it is evident that they are all mutually dependent; and that they are, at the same time, concentrated within a certain limited space, with the sole exception of St. Kilda. It is also to be remarked that no trap occurs on that part of the continent which adjoins the northern portion of the group; the northernmost mass on the mainland being that of Airdnamurchan. By means of this district, and that of Morven, the connexion between the southern and northern portions is established, in this case, as in that of the secondary strata. Mull, which forms the largest continuous mass in the southern division, as Sky does in the northern, is not only connected with Morven, but appears equally related to a considerable tract of these rocks, fragments of which will be found extensively scattered, both over the neighbouring mainland, and among the islands on the coast of Lorn which will hereafter come under review. The nearest connexion of this nature is that already pointed out on the Morven shore, where an extensive district of trap is seen extending to Airdnamurchan in a northerly direction, and terminating towards the south by an abrupt juxtaposition to a mountain of gneiss, through which it sends veins; the line which separates the one substance from the other being almost perpendicular, while the common height of the ridge at this junction is not much less than 2000 feet. It offers an interesting example of a mode of connexion between these two classes of

rock of which I have not met with any corresponding instance.

There is so wide an interval between the trap of Morven and the nearest analogous rocks which occur on the mainland, that it at first appears scarcely justifiable to suppose any connexion between them. I allude to the great tract of claystone and porphyry, which extends interruptedly from Ben Nevis through Loch Leven to the head of Loch Etive, and includes Glenco. But if the interval between this tract and Mull is considerable in this direction, it is materially contracted when we trace those rocks towards Ardchattan and the lower parts of Loch Etive; by which we are conducted, with little interruption in the recurrence of porphyritic and trap rocks, first to Oban and the adjacent islands, and ultimately to Inverary. Between those islands and Mull, the connexion is not only geographically more intimate, but the similarity more striking; nor does there seem much reason to doubt, that the trap of these islands and that of Mull are all parts of a mass which, if it were not once connected where a sea now divides it, was at least formed under similar circumstances. That the various disjoined masses of trap have actually been once continuous, is rendered highly probable by the circumstance pointed out in Staffa, which need not here be repeated; since the interval in that case is not greater than in many others where no such proofs of an original connexion exist.

With respect to the porphyries of Argyllshire however, it may be doubted if there is any reason for imagining an identity in time between them and the proper trap rocks. While the latter are almost invariably connected with the secondary strata, the former lie on the primary. Independent of this, and notwithstanding a community of structure and relation to the rocks on which they severally repose, and with which they interfere, those porphyries present mineral characters sufficiently distinct perhaps to justify a separate origin; while their affinity

in many important particulars to granite, may suggest the idea of a period of time more remote and more nearly corresponding with that in which this rock was formed.*

* These porphyries contain pinite, a mineral which I have also found in the porphyritic veins of Ben Gloe and the adjoining mountains. The granite of the mainland in the vicinity of Sky contains spodumene, a substance which has not hitherto been observed in Scotland.

INTRODUCTORY REMARKS ON THE SANDSTONE ISLANDS.

THE impossibility of making any arrangement that should perfectly combine geographical with geological convenience, has rendered it necessary to form a separate division for these islands. It is true that many of the Trap islands contain the sandstone in so large a proportion as to have unavoidably led to a partial description of that rock: it has even been necessary, for the sake of illustrating that group, to describe two spots, Soa and Longa, which, rigidly considered, should have been arranged in this division. Still, it is necessary to enter more at large into the examination of this substance, for the purpose of elucidating the nature of a series which seems to have escaped attention, and which, from its occupying a large and remarkable portion of the Scottish continent, is of peculiar importance in the history of that country. The geological interest of the subject must atone for the insignificance of the islands included under this general head.

Many small islands, of similar composition, besides those here enumerated, are found on the western coast; such as Island Ew, Island Greinord, Martin Island, Longa in Gerloch, and others. Descriptions of these would have been superfluous, as they present no specific interest. Their general characters will be sufficiently explained in the summary which concludes this division, while, in a geographical view, they will also, like many of the minuter islands that have been passed over in this work, find a more appropriate place in a description of that continent to which they are so nearly attached.

THE CROULIN ISLES.*

With the view of extending the comparison between Sky and the mainland, these have already been cursorily mentioned in the general remarks on the Trap islands; their vicinity to the shore affording the means of establishing the geological connexion of that island and the continent.

The southernmost and largest of the group appears to be about a mile in length, and is known by the name of Croulin more; the next is Croulin beg, and the northernmost is called St. Rufus's island. The structure of the whole three is so similar, that it is unnecessary to distinguish them in description, or to give a detailed account of the rocks of which they are composed; since the mineral characters of these have been amply described already. They are the same substances which form the upper line of the sandstone in Sky, namely, hard red sandstone, schistose sandstone, and graywacké schist. The bearing of the strata is, like those of Sky, north-easterly, the dip being also to the north-west as in the uppermost beds of that island, and the angle of inclination lying between twenty and thirty degrees. They are traversed by veins of trap.

If the position of the strata in these islands be compared with those of Longa and Scalpa, it will be seen that they also coincide in bearing with the two latter, at a distance of six or eight miles, a deep sea intervening; from which it may be concluded that these are all portions of the same line of strata. This was already noticed in a cursory manner in treating of Scalpa; and since every thing which appeared necessary respecting those general connexions of the sandstone has already been said, it is here unnecessary to enter into any further discussions

* The Red isles. See the Map of Sky.

on that subject. But it is nevertheless important to remark, that these islands are no less intimately connected with the adjoining shore of Applecross, as well in geological structure as in geographical position. This district forms the most extensive and the most continuous portion of the primary sandstone of the north-western coast; while the mass of strata of which it is constituted rises into high mountains. These strata do not here, as in Sky and Loch Alsh, alternate with the gneiss, but repose on it; while they are also generally placed in a more uniform inclination and at much lower angles. Hence they might, on a cursory view, be considered as distinct from those of Sky. But they become connected with them by means of the Croulin islands, which, while they coincide in direction with the strata of Scalpa, are no less coincident with those to which they approximate on this part of the continental shore. Thus the community of the whole of this sandstone, under all its variations of position, may be deduced; further proofs of which will be offered when the general comparison of these islands with the continent is attempted.

THE SUMMER ISLES.*

THESE form a considerable, though a scattered group, lying off the entrance of great Loch Broom. Including the small with the large, they amount to about thirty; but of these, only nine or ten are of sufficient size to be occupied as pastures, while one alone, Tanera more, is inhabited.

Tanera more is about two miles in length and one in breadth, and, independently of a farm, contains a fishing establishment with extensive smoking houses, now rendered useless, like others on this coast, by the long continued desertion of the herring shoals. It presents an irregular and rocky surface, rising to the height of 400 or 500 feet.

The other islands are all similarly rocky, but of much less elevation; nor do they present any circumstances worthy of particular notice; being uniformly bare, and void of picturesque beauty, unless where their rocky, and often high shores, are wrought into caverns and points by the incessant breaking of the sea. The variety and frequency of this class of objects throughout the western coast, almost destroys the interest first excited by their novelty and effect. The voyager who has passed through the arches of Cape Wrath, and has visited the innumerable specimens of gloomy and grand scenery presented by the caves of Whiten head and Loch Eribol, will scarcely turn his boat aside again, even to view the towering pinnacles of Rochill and the Ru Storr.

* The reader must consult the large Map of Scotland for the position of these islands, as they could not be introduced within the limits of the general Map which accompanies this work. That map will indeed be often useful on other occasions in reading this work, and it is evident that no reduction of it, here admissible, could have answered the same purpose.

Carnisker alone, among the whole group, consists of gneiss similar to that of Ru Carnderig, near which it lies. The peculiarities of this gneiss have already been enumerated in the synopsis formerly given, so that it is here unnecessary to dwell on them. It is the variety characterized by the predominance of compact felspar.

It is scarcely necessary to distinguish the remaining islands* in the geological description, as the same general characters, with but little variation, are found in all.

They all consist of a red sandstone similar to that of Rasay and of the upper beds in Sky; the finer kinds alternating irregularly with the gravelly and conglomerate beds. In respect to position, the strata present some circumstances requiring attention, on account of the deception which they produce when seen from a small distance; the islands thus formed, appearing to consist of sandstone reposing on gneiss. Eilan anaich, among others, offers a good example of this peculiarity. The southern part of that island consists of strata nearly horizontal, and hence the surface in this quarter is a smooth grassy plain. At the northern extremity, they are elevated into a position highly erect, and often vertical, so as to produce a rocky irregular surface; while the stratified character nearly disappears; the rock being split into confused fragments of pyramidal and prismatic forms. Thus, even at a short distance, the southern portion seems to repose in an unconformable manner on the northern; and as the same appearance occurs perpetually along this coast where the sandstone reposes on the gneiss, it might easily be registered as an example of this latter occurrence.†

* The names of the principal islands are the following. Tanera, more and beg, Muligrach, Ristle, Glasleak, more and beg, Eilan chlearach, Eilan Dhu, Eilan anaich, E. Wheit and E. Drum.

† This fact presents additional evidence of the impossibility of determining the nature of rocks by the character of their outlines and disposition, even where these are within a small distance. It was not for want of experience in these rocks that I first laid them down as

The same disposition may be observed in many other of these islands. No apparent cause for this sudden and violent disturbance can be discovered, neither granite nor trap being present; while it is at variance with the prevailing character of this sandstone, which, on the adjacent continent, is disposed with the utmost regularity, varying but a few degrees from the horizontal position, and thus covering a great space. In Muligrach island the progress of this change is visible; since the horizontal strata can be traced gradually undulating until they become erected into a position nearly vertical, when the marks of stratification disappear.* The change of position is here accompanied by empty fissures and caverns, indicating that some subsidence, or other analogous changes, of a date probably more recent than the last deposits of rock, have been concerned in its production. With respect to the dip of these strata, it is necessarily variable, as the preceding statements will show; yet, throughout the whole group, there is an average general inclination toward the south-east.

examples of sandstone and gneiss. That there is no conviction in these subjects without actual contact, is a rule of which the geologist should never lose sight.

* Plate XXXII. fig. 9.

HANDA.*

This island is situated near the shore between Scourie bay and Loch Laxford, being of a roundish figure, about a mile and a half in diameter, and rising into a sort of inclined table land of about 300 feet in elevation. At the eastern side, the declivity of the surface is gradual, but the western is an almost unbroken vertical cliff, presenting, from its smoothness, and the divisions and colour of its strata, a disagreeable resemblance to a gigantic brick wall. This cliff is wrought into caverns and tenanted by myriads of sea fowl, of which it is a resort scarcely less noted than Ailsa. The surface is covered with rich pasture, forming part of a large sheep farm; the insular situation being peculiarly adapted to certain parts of the management of large flocks under the extensive system in use in Sutherland.† Near the edge of the cliff on the northern side, is seen one of those funnel shaped cavities communicating with the sea, resembling the Bullers of Buchan or the Tol pedn Penwith of the Lands end, but of small dimensions.

In a geological view, Handa forms one of those singular detached portions of sandstone in which this coast abounds; being separated by a space of seven miles from the nearest mass of the same rock. The strata

* For this island, like the former group, no place could be found in the general Map. In a geological view it is of no moment, and for its geographical position the reader is referred to the Map of Scotland.

† The reader who may chance to have interested himself in the present management of Highland estates, may be informed that the rents of these farms vary from £1500 even to £4000 a year, and that they extend over spaces sometimes exceeding thirty miles in length. Hence the apparently depopulated state of the country; the agriculture being chiefly confined to the sea shores, and but few shepherds being required for the management of the most extensive farm.

of which it consists are generally of a fine texture, and remarkably regular; undulating in a slight degree, but so little deviating from the horizontal position, that no predominant dip can well be assigned. If there be any, it is toward the east. Like the Summer isles, the rocks consist entirely of the indurated red sandstone, without any alternation of the grey varieties, or of the schist which occurs in Sky and in Rasay. This indeed is peculiar to the whole of the kindred rocks on the continental shore, from Loch Carron northwards, the change occurring in Applecross; whence, even to Cape Wrath, no alternating substance except white or grey quartz rock is scarcely ever found.

In a general view it is interesting to trace the affinity between Handa and the nearest masses of the same rock on the coast. The first will be found near the entrance of Loch Inchard, whence, to near Cape Wrath, it occupies patches of greater or less magnitude, and often of very small dimensions; all of these being characterized by the same tenuity, evenness, and horizontality of stratification, and all similarly reposing on that gneiss with which in other parts of this coast they alternate. So small are some of these patches that the above mentioned one near Loch Inchard does not exceed 100 yards in diameter. At the Ru Carnderig near Loch Broom, a similar one is seen, occupying a space of a few feet only, and, in the same manner, involved in gneiss. On comparing all these scattered portions, it is impossible to avoid imagining that they have formerly been continuous, and are the fragments of an extensive deposit, once occupying the whole of this coast, and now separated by the action of the sea and other wasting causes. This notion is confirmed by the palpable appearances of rapid waste exhibited on the shores on each side of Cape Wrath; where every variety of ruin is seen, in the pinnacled cliffs, in the sliding down of huge masses, and in the heaps of fragments which,

by their annual fall, cause the sea to retire before them.

It will presently be seen in the general account of this series, that the same character pervades it in the interior. To have rendered that sketch more perfect, a map of the continental districts where it occurs would have been required. That map must be reserved to a future period; but to have omitted all notice of these, would have been to leave imperfect a subject of which the interest chiefly depends on the extent and general characters of the objects which it comprises. It is convenient to describe insulated portions of the surface, but it is necessary for geological science to trace their affinities to each other and to the general structure of the earth.

GENERAL REMARKS ON THE SANDSTONE ISLANDS, AND ON THE SANDSTONE OF THE WESTERN COAST.

FROM the various remarks already made on the red sandstone series, in describing the numerous islands where it occurs, the greater number of its characteristic features may be collected. Yet there are many circumstances of importance in its history, which will not be found in those islands; nor could the exact nature and extent of its relations be understood, without a sketch at least, of that part of the mainland in which it occupies an important, as well as an intricate and singular situation.

The islands included in this division, together with those portions of the Trap islands formerly described that consist of the red sandstone, must all be considered as parts of one mass, which occupies an interrupted line on the western shore from Glen Elg to Cape Wrath, and extends to a certain distance in the interior country. That space could not be defined without the assistance of a map; but it is sufficient for the present purpose to say, that it is limited, in a general way, to a breadth not often exceeding thirty miles, and rarely attaining that dimension. Throughout this tract it occurs in a very dispersed manner; sometimes, as was noticed in Handa, forming distinct patches of various dimensions, at others occupying considerable tracts, and in a few instances, constituting single insulated mountains or mere mountain summits. This latter form is among the most singular of the appearances it presents; since that disposition occurs in no other stratified rock in Scotland, although not uncommon in the members of the trap family.

The external great outline presents an infinite variety. In many places, as at Ru Udrigil and Ru Rea, this sandstone forms a smooth land; with an even, continuous, swelling outline like those of alluvial countries; although this coast is characteristically free of alluvial matter, and nothing is found covering the bare rock but the usual shallow mountain soil. In a regular progress from this tameness of outline, it forms hills of all dimensions and of every variety of aspect; round, conical, ridged, or serrated; ultimately rising to the greatest average altitude of the Scottish mountains. Kea Cloch in Ross-shire presents in itself examples of all these forms, the summits being in some places no less strongly serrated than those of the Arran mountains; while the height is not less than that of Cruachan, appearing to range between 3500 and 3700 feet. Further examples of the prolonged ridge are seen in Ben more (Coygach) and in Suil veinn; and of the conical form, in Coul beg and Coul more; all of these attaining an elevation of about 3000 feet. Forms similarly remarkable occur in Sleugach (Gerloch) and in the mountains of Loch Torridon, which present naked and precipitous rocky faces of 1000 feet or more in height, with an aspect as rugged as that of the mountains of Sky.

The independence of many of these hills forms one of the most remarkable parts of the character of this rock. In many places they rise suddenly from a hilly land of moderate elevation, composed of gneiss; attaining at once to a height above it of 1000 or 2000 feet, and separated from any similar hill by a space of many miles; thus giving a peculiar character to the distant outline of Sutherland and Ross-shire. In other places they form groups more or less condensed, but still separated from each other at their bases by the gneiss on which they rest. Where they are insulated they produce a very striking effect, of which examples occur in Suil veinn and Coul beg. Similarly powerful effects

result from the suddenness of their rise; the summit together with the whole declivity being visible from the base. In this manner Sleugach is seen from Loch Mare, presenting a very striking object, with an alpine effect rarely found in Scotland; where the foreshortening that results from a gradual declivity, generally conceals the summit and diminishes the apparent altitude.* It may easily be imagined that under these circumstances the mountains of red sandstone are very difficult of access: in some cases they are inaccessible except to the practised shepherds.

With respect to the structure of this rock, it presents various aspects, although it is always stratified. In the predominant examples the strata are very thin and equal, and in all these cases the angle of inclination is low, deviating in some instances but slightly from the horizontal position. It is not uncommon for the beds to possess a schistose, or at least, a flaggy structure, of which the two Ben derigs in Diurness present remarkable examples; their summits exhibiting a continuous surface resembling a pavement of loosened tiles. At Loch Torridon, where the same structure exists, the surfaces of the flags bear those marks of undulation which occur in the secondary sandstones and resemble so much the marks left by the sea on sandy shores.

Where the angle of inclination becomes considerable, the distinctness of the stratification diminishes; and where the beds assume the vertical position, it requires great

* On the declivity of the adjoining mountain Ben lair, which descends into Loch Mare, are seen the remains of one of the ancient fir forests of Scotland in a very singular situation. The angle of declivity is here not less than sixty or seventy degrees, and the face is a naked rock without an atom of verdure, except in a few of the rifts which pervade it. At a short distance it resembles a huge wall, of many hundred acres in superficies, and not less than 400 or 500 feet in height. This is every where covered with trees of large growth, their roots penetrating the fissures and their tops standing out from the rock behind at a very short distance. The effect hence produced is very striking.

care to discover any marks of that order; the rock acquiring the aspect of some granites, or that of the irregular gneiss by which it is accompanied, and being split into prismatic or angular fragments. This feature, which was noticed in describing the Summer isles, occurs also at Loch Greinord, under peculiarly interesting circumstances which will be presently described. Striking examples of the same nature may also be seen at Gerloch, where the vertical sandstone is so intermixed with the gneiss that it is scarcely possible to distinguish the one from the other; the external aspect of both being the same. The occurrence of this irregularity in those cases specifically where the angle of inclination deviates materially from the horizontal plane, appears to prove that it has in these cases undergone a disturbance since its deposition; a circumstance confirmed by the facts already pointed out in Muligrach island. Marks of disturbance, of an analogous and equally explanatory nature, occur in several other places; of which none are more remarkable than one in Loch Alsh, where one set of strata may be seen reposing on another in an unconformable manner; both being straight, and the irregularity and fractures occurring only at the points of abutment. It might be expected that the pinnacled summits and detached hills already mentioned, had resulted from the waste of the erect varieties; but on Kea cloch, as well as in Coul beg, Suil veinn, and most of the other hills, they are produced by the wearing down of strata nearly horizontal; the harder portions, in the former case, remaining like pillars of masonry or artificial cairns of stone. The islands in Loch Mare afford an interesting example of the horizontal stratification; forming a beautiful labyrinth planted with ancient firs, and the waters of the lake winding among them in channels so numerous and intricate, that it is difficult to explore the way.

In the account of Handa it was already suggested that the removal of large portions of this deposit was

the probable cause of the present detached state of the several masses. That opinion is strongly confirmed by taking an extended view of the west side of Sutherland and Ross-shire. It will thus appear, that the country consists of a basis of gneiss forming an irregular and hilly surface, which in extreme cases varies in elevation from 100 to 1500 feet, but which often presents a table land of considerable height with inequalities of comparatively small account. On this base are placed various mountains, either far detached from each other or collected in groups; and all rising to an average altitude of about 3000 feet above the level of the sea, or of 2000 above that of the gneiss. The stratification of these, it has been shown, is either horizontal or slightly inclined, with a variety of dip, in which the eastern however prevails; while the declivities of the mountains on all sides, consist of the broken ends of the strata. In no case does the declivity consist of the surface of a stratum, as in mountains of micaceous schist or gneiss; in which it is usual to find the opposed declivities formed alternately of the surfaces and of the edges of the beds. It is scarcely necessary to say that mountains so formed could not have been produced by the elevation of the strata, as in the last named rocks; and it is, on the contrary, evident that, like mountains of trap, they owe their present shapes to the abrasion of their sides.* It follows therefore, that the whole of this country has been once covered with a body of sandstone, equal in thickness, in certain points at least, to the present remaining portions; the variations of the dip marking the undulations of that mass when in its entire state. The extreme depth of this deposit, as far as it can now be discovered, may be measured by Kea cloch, of which the altitude has already been given; since the strata are there nearly horizontal, and extend from the summit to the base, where their further depth is con-

* Plate XXXI. fig. 4.

cealed by the sea. The detached portions which occupy the shore, confirm this opinion; and in extending this view to the islands of similar formation, we are tempted to imagine that the large intervals now occupied by the sea, were once parts of a continuous tract of land.

The remarks already made on Sky, show that this red sandstone graduates into gneiss; and similar gradations will be found to occur on the mainland. They are visible in Loch Alsh, in Glen Elg, and in Loch Carron; and, in all these places, the transition is effected, as in Sky, by means of the varieties of schist and grey indurated sandstone there enumerated and described. In Sutherland, that gradation takes place by means of quartz rock; which on the one side exhibits a transition into the red sandstone, and on the other into gneiss.

In a large proportion however of the mainland, no such transitions are found, but there is a sudden and complete alternation of the two rocks. This is more particularly the case from Loch Kishorn northwards; nearly the whole tract consisting of the red sandstone only, free from all the alternating schists and grey sandstones that occur in the places just mentioned. It might perhaps be hence imagined that these were different formations; but that suspicion is removed by the facts visible in Sky and on the adjoining continent, where the same red sandstone that can be traced to Loch Kishorn and to Loch Alsh, alternates with the schistose rocks in question; as well as by the connexion of the Croulin islands already pointed out. The alternations with gneiss are visible at Loch Carron and great Loch Broom; the sandstone in the latter place lying beneath the gneiss, and both having a common dip to the south-east.* It was also already remarked in treating of Sky, that the sandstone occurred on the shore of Glen Elg, interposed with a common dip between the gneiss of this island and that of the mainland; and in the same manner it is found alternating with this rock in Loch

* Plate XXXI. fig. 2.

Alsh and Loch Duich. In Sutherland the examples are numerous, and may be witnessed at Loch Eribol and in Glen dhu (Assynt); the substance in contact, and immediately subjacent, being often that quartz rock which in the same vicinity alternates with the red sandstone.

The alternations of the two latter rocks are also frequent in Sutherland; and throughout this country the quartz rock forms an essential part of the series, as it does in Sky; occurring in so interspersed a manner that it is rarely possible to distinguish the two on a map, however large its scale. It is from this cause, apparently, that some of the mountain summits in this tract present quartz rock surmounting red sandstone, or occupying that position on the gneiss which the latter rock does in Ross-shire. There is indeed no reason to doubt that the quartz rock is here, as in Sky, a part of the red sandstone series; although differing in no respect from that substance as it is found alternating with micaceous schist in Isla and Jura.

Lastly, it must be remarked with respect to the position of the red sandstone, that it is often unconformable to the gneiss. As it is unnecessary to multiply examples, I need only say, that instances of this relative position occur in Suil veinn, and in many other parts of the extensive tract under review. In these, the gneiss lies at angles considerably elevated, while the beds of sandstone are nearly horizontal. Wherever the contact of the two is to be observed in these cases, an intimate union will be found to exist; the irregular surface of the gneiss being filled with a breccia formed of its own fragments, strongly adhering, as in the instances already mentioned in Lewis and in Rasay, and the stratified structure of the sandstone commencing only after these irregularities are filled. Whatever difficulty may be imagined to exist in explaining this double relation which the sandstone possesses to the gneiss, there is no reason to doubt the identity of the whole deposit, as the points of connexion and continuity are nevertheless of frequent occurrence.

Little remains to be said respecting the mineral characters of this sandstone after the details already given in other places, as it would be superfluous here to recapitulate them. It is principally distinguished from the red sandstones of the centre of Scotland, by its extreme hardness and by its crystalline texture. In this respect it often equals common quartz, no distinction between the constituent grains being visible, but the whole appearing as if cemented by a general solution of silica. It is often however, even in these cases, gravelly, while it occasionally consists of large fragments, angular as well as rounded, of different colours, compacted into one crystalline mass.

One remarkable variety indeed occurs in Sutherland which it is here necessary to mention, as it has not fallen under review in any of the islands formerly described, where the details of the composition of this rock have been examined. The grains of quartz are in this case cemented by a blue instead of a red clay, and the colour of the rock varies in consequence; passing through several tints intermediate between pale grey and red, and being thus occasionally of a dark brown. It is generally easy to trace this blue clay to the decomposition of argillaceous schist; since, in the course of the grey beds, minute fragments of that substance will be found occasionally interspersed. In some situations these increase in quantity, becoming also of larger sizes; and thus there is formed a variety of mixtures passing from a fine grey sandstone to a gravelly graywacké, and ultimately to a conglomerate in which large fragments of schist predominate. These varieties resemble in every respect but colour, the graywacké and conglomerate schists that accompany the quartz rock of Scarba and Jura; the red colour of the quartz, or of the felspar, which also forms a part of the mixture, conferring on them a peculiar aspect. In a few places it assumes characters which have been supposed peculiar to certain varieties of the later red

sandstones. Thus, on Kea cloch, it contains the white spots and stripes of the variegated sandstones, and a mottled variety is also found in the Ben derigs. Where the felspar is abundant, it sometimes becomes white to a certain depth from the surface, examples of which occur in Tanera. In no instance have I observed it to contain mica, nor, with the exception of red jasper and that of the schist just mentioned, any substances but quartz and felspar. In a few instances where the fragments are angular, the mixture is so condensed that it can scarcely be distinguished from granite. In others, equally rare, it is so soft as to admit of being wrought as a freestone; but this condition seems always to exist within a small depth from the surface. With an exception which was formerly noticed under the article of Lewis, it is perhaps worthy of remark that in no instance hitherto it has been found to contain imbedded limestone, an occurrence very common in the red sandstones of later origin. None at least fell under my notice throughout the whole of that extensive tract which reaches from Loch Carron to Cape Wrath.

With respect to the position which the several varieties hold toward each other, it must now be remarked that the coarser are irregularly intermixed with the finer in almost every place where they occur; so that no rule respecting their relative positions can be given. The only exception exists in those cases where this rock is in immediate contact with the gneiss, and in an unconformable position to it. Here the conglomerate alone is found for a certain space upwards in the order of the beds; consisting of fragments, very slightly altered in form, united by the smallest possible quantity of sand and finer materials, and always appearing to be portions of the rock immediately subjacent. In all other cases the beds of fine and of conglomerated structure alternate in an uncertain manner, or the same bed presents in different parts, differences of composition in this respect. It is

rare indeed to find any bed which, however fine in its predominant character, does not somewhere contain larger fragments. With the exception above noticed, there is also no connexion between the structure and the relative place of the strata in the order of superposition; as the summits of the highest mountains, equally with the lower beds of which they are formed, present extensive masses of the conglomerate. The fragments of these, it must however be remarked, are rarely if ever so entire as in those beds which repose immediately on the gneiss; almost always bearing, in a greater or less degree, the marks of attrition.

It is scarcely necessary now to say that this sandstone must be ranked in the class of primary rocks. On no other view can the preceding facts be explained, notwithstanding the occasional points of resemblance which it presents to those of the secondary division. It must therefore be considered as a red primary sandstone; and that it is not even the latest of the primary strata, is evident from the preceding history of its connexions.

No objection need arise with respect to the use of the term primary, as applied to a rock composed of the reunited fragments of former rocks. That term has here, as on other occasions throughout this work, been substituted for the word primitive, and is purely relative; implying nothing theoretical respecting the origin of any order of rocks, whether stratified or amorphous. Nor is this sandstone a solitary example of the mechanical recomposition found among rocks of the primary division. The instances of this structure occurring in the quartz rock of Jura and the associated islands, are equally remarkable; and there are indeed striking analogies between that series and the present in many important particulars. The obvious differences, in fact, frequently consist in little else than colour; the essential one in these two cases being the presence or absence of felspar, whence, in the red sandstone, that colour

is derived. As this latter rock appears to have been generated from the materials of gneiss and granite, so the former has probably been recompounded principally from the fragments of previous quartz rock, micaceous schist, and argillaceous schists; although the existence of felspar in the former, shows that granite also must have been one of the substances engaged. The beds which present the conglomerated and graywacké structure, are similar in character in both; but it is unnecessary to enumerate the various points of resemblance which those who have attended to the preceding descriptions cannot fail to have remarked. With respect to the existence of an unquestionably mechanical structure in a primary rock, it may also be remarked that the micaceous schist of Isla, which contains fragments of granite and quartz rock, presents a decided example of it; as do also those rocks of the graywacké and conglomerate structure, which are found among the argillaceous schists in various parts of Scotland. If even the red sandstone of this district be considered as a modification of quartz rock, no alteration will follow in the nature of any of the views that have here been brought forward. The same history will be transferred to a new term, not to another substance; and the same consequences will follow that so often result from the substitution of one word for another; in the best cases, that of leaving every thing precisely where it stood before; and in the worst, confusion and obscurity instead of light and order.

In all the situations hitherto described where this rock is followed by the secondary strata, these have invariably proved to be the conchiferous limestone and the white sandstone which in Scotland succeeds that rock. It became therefore an interesting object of research to discover it in contact with a red sandstone of acknowledged secondary formation, and thus it was at length found in Loch Greinord. Here, two small patches of the secondary strata are seen occupying a space not

xceeding, when jointly taken, a mile in diameter, and remarkable for being the only fragment of these strata to the north of Airdnamurchan. They were lately mentioned in the general comparison of the Trap islands. The primary sandstone is here in one part vertical and irregular, in another of a more even structure, but still possessing its distinguishing characters. Above it, the red secondary beds lie in a position nearly horizontal, and are followed by a white calcareous sandstone, with interposed beds of limestone, in all respects similar to that of the coast of Morven and of the trap islands. The contrast between the two classes of sandstone, both in position and character, is highly interesting; leaving no more doubt of the distinction between them than if gneiss, instead of red sandstone, had been the lowest rock.*

A few observations are yet required on the double position occupied by this sandstone with regard to the gneiss. It was remarked in the account of Mull, that the secondary strata held positions respecting the primary, which were in some places conformable, in others the reverse. The same indifference of relative position between the two, occurs in so many other situations as to be no longer matter of doubt; while, on considering the circumstances under which the former were deposited, it appears to be a natural result of these, and a necessary consequence of the previous inclinations of the primary rocks on the surface of which the deposition took place. The secondary strata are however not universally characterized by a low angle of position, but are found occupying almost every angle from the horizontal upwards; a circumstance which renders their degree of inclination as unavailing a distinction as their relative position to the primary. In comparing distant portions therefore, they would seem to possess a want of conformity to each other; yet in tracing them

* Plate XXXII. fig. 8.

continuously they have hitherto been found strictly consecutive in this respect; the differences in distant portions arising solely from intermediate flexures or undulations which do not affect this general conclusion. In a few instances nevertheless, a real want of conformity between two approximate portions of secondary strata may be observed; but the presence of trap in these cases, or the occurrence of other disturbing forces, point out the causes, and show that these irrelative positions have been the consequence of changes posterior to their regular deposition.

The same general rule has been supposed to hold among the primary strata, and the present instance therefore affords a striking exception. In the tract under review, it is conspicuously exhibited in the north-west angle of Sutherland; and the whole of this district indeed presents examples of the conformable and of the unconformable relation borne at the same time by one rock, to those with which it is associated. Whatever light a more extended investigation into the primary rocks may hereafter throw on this subject, it is not at present easy to offer any explanation; yet it must be remarked that the difficulty, if it be such, is of an artificial nature; since it is founded on the assumption that all the primary strata, like the secondary, have been formed during one distinct period of repose in the surface of the earth. It might nevertheless be suggested in explanation of the present anomaly, and without rendering it necessary to disturb this hypothesis, that disturbance and waste combined may have produced the double position of this red sandstone. It has been remarked that in many places the same mass can be continuously traced from a horizontal or slightly inclined, to a vertical position, and it is probable that this change has been effected by posterior derangements. Assuming any given portion of such a mass, it is only necessary to suppose the point of transition removed, and the consequent non-conformity will immediately follow.

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That which is so readily imagined on a small scale, is as easily transferred to a larger; since, in the operations of nature, these terms are of no moment; and thus the horizontal sandstone of this district might be supposed essentially and originally continuous with that which occupies high angles and is now found actually alternating with the gneiss.

But whatever partial explanation may be afforded by this supposition, it does not overcome the difficulty. It is in many places obvious that the beds of sandstone are placed on the edges of the gneiss beds; a proof that they have, in these cases, succeeded after an interval which had permitted the inferior strata to assume a new position. If, under these circumstances, the sandstone which alternates with the gneiss, be deemed originally continuous with the unconformable beds, it will also follow that the gneiss is essentially unconformable to itself; or that there are two distinct deposits of this rock of which the one is placed in a reverse position on the other. This supposition is perhaps no more unreasonable than the former; and it is obvious that the difficulty, as far as this fact alone is concerned, is, as before remarked, hypothetical. The science of Geology is not yet sufficiently advanced to enable us to select an exclusive difficulty where every thing is as yet obscure; it is not entitled to pronounce on that which is an anomaly and that which is a law. Should it be determined by future investigations, that there are essential disturbances among the primary rocks, that one or more revolutions, analogous to that which appears to have occurred between the primary and secondary strata, have taken place in the former, the present difficulty will vanish, and the rule of conformity will not be found to regulate this division in nature. That such a disturbance has actually occurred in this instance, appears proved by the peculiar circumstances under which this sandstone first appears, in those cases where it is strictly unconformable to the

gneiss. The conglomerate with which it commences, proves that the latter rock has been covered during a certain period of repose by fragments of its own substance; while the very construction of the sandstone also shows that it is the produce of materials which have been furnished by rocks previously existing. The magnitude of this deposit marks to a certain degree the interval of time which must have passed between the two, and proves, that even among the primary rocks, there have been long intervals of time, attended by changes and revolutions, and productive of depositions of rock, analogous to those which occur between the primary and secondary divisions. In its essential characters this sandstone, where unconformable, may therefore be considered a kind of secondary rock, when compared to the primary with which it is immediately connected.

It may still be questioned, by those to whom these facts are new, whether the unconformable and the alternating sandstone are the same, or whether the former is not actually a secondary sandstone? I can add nothing to the statements on this subject already given. The facts are open to examination, and perhaps they may still require it. To introduce confusion where order was supposed to exist, is no less painful to him who describes than to him who reads; yet the transition from one species of order to another must pass through confusion. The history of chemistry is not the only proof of this truth. Though the preceding views should be incorrect, though the sandstone of Sutherland should be proved secondary, still this investigation and these doubts will have their use, by extending the history of the secondary strata, and by establishing the existence of circumstances at variance with the predominant characters of their lowest member. It is not difficult to see that, in such an event, important modifications would also be wanted in the characters of the secondary division; and that the anomalies thus generated will not be less troublesome

to him who shall attempt to form a new arrangement on this principle, than they are difficult of explanation on that which has been here assumed.

In concluding this article it is proper to remark that this important rock is not limited to the west coast of Scotland. It occurs in the centre of Sutherland, extending in a narrow interrupted line and surrounded with gneiss. It appears also to form a large portion, if not the whole of Caithness; where it alternates with an argillaceous schist most commonly of the graywacké character. There, it has hitherto been considered as a secondary rock. From the affinity of the Orkney isles to this tract, there is reason to suppose that they are also of similar composition. In Aberdeenshire also, it appears to have been mistaken for a secondary sandstone; occurring there in detached portions. It remains further to be inquired whether the whole, or part, of the red sandstone of Cromarty and Moray, is not the same; a circumstance of which there appears little doubt; although where the two classes of this rock occur together, it would require much caution in drawing the distinction and in ascertaining the common boundary. But I must terminate a discussion already protracted beyond the allotted limits.

INTRODUCTORY REMARKS ON THE SCHISTOSE ISLANDS.

BEFORE proceeding to the description of the different islands which compose this group, it will be useful to take a general view of the whole; reserving the comparison of the results deducible from their physical history and geographic connexions, until they have been all examined. Their strong resemblance to each other in structure, the obvious repetitions of similar strata which occur throughout them, the mutual correspondence of their outlines and of the bearings of their strata, together with the intimacy of their geographical positions, render this association as natural as it is useful for the illustration of each individual and the comparison of the whole. If a few of the rocks occurring in these islands do not possess the schistose structure, that term is, nevertheless, scarcely exceptionable; since they chiefly consist of those primary stratified rocks, namely, micaceous schist, quartz rock, argillaceous schist, chlorite schist, and other associated substances, which all, in a greater or less degree, present the schistose character. Although the whole of this group thus possesses a common character, it is further divisible into portions, each of which is distinguished by a common bond of resemblance that does not pervade the remainder; one only, Lismore, being excluded from either of these subdivisions.

The first of these subordinate divisions may be designated by the name of the Slate isles, and it includes Kerrera, Seil, Luing, and Torsa; Shuna, which is geographically and popularly associated with these, appertaining, in geological character, to the third subdivision. The characteristic of this group, is the prevalence of clay

slate. The subdivision here entitled the Quartz isles, comprises the chain of Lunga, Scarba, Jura and Isla; to which Colonsa, Oransa and the Garvelach isles may be added; the principal chain being characterized by the prevalence of quartz rock, and the other islands being evidently connected with it by community or alternation of its other leading strata. The last subdivision includes, together with Shuna, the Craignish isles, the isles of St. Cormac, Gigha, and Cara, and is distinguished by a series of schistose rocks in which chlorite schist predominates, and which occupies an extensive tract on the adjoining mainland. It will be convenient to discriminate it from the other groups by the name of the Chlorite isles.

The islands of Kerrera and Seil form the immediate bond of union between Mull and the Argyllshire coast, containing the trap rocks of the one and the schistose strata of the other. A very small portion also of secondary strata, occurs in the three northernmost, but in parts so detached and minute, that they almost disappear in the particular details. The most obvious feature of the connexion will be seen to consist in the trap which prevails in the northernmost islands and on the shores of the mainland immediately opposed to them. The rocks of this family, from their analogy in position, correspondence in structure, and geographical proximity, seem to be detached parts of the trap of Mull and Morven, as I formerly had occasion to remark. The intermediate rocks and islets, otherwise little worthy of notice, become in this respect interesting, as serving to connect by some intermediate points, the leading masses which form the principal islands, whether belonging to the one set of rocks or the other. With this view nearly the whole of them were examined; a task rendered very difficult by the strength and rapidity of the tides, the boisterous nature of this sea, and the consequent difficulty of landing; circumstances which present the only apology that ought to be offered for the imperfections which may

still remain in their history. These detached parts are even more useful in connecting the islands that consist of stratified rocks, with each other and with the coast, than in approximating the masses of trap; a rock, it is probable, which is often originally of an insulated and partial nature. By tracing in succession the several islands here ranked, as nearly as possible according to their geographical and physical relations, by attending to the connexions indicated by the various scattered portions, and by examining the neighbouring coasts of the mainland, a continued series may be established; which will be found interesting whether simply considered as proving an existing regular order, or as indicating past changes, from which their continuity has been broken, and the coasts have received their present forms.

It is proper here to remark, that the order adopted in describing them, is not conformable to the one elsewhere followed; namely, that of commencing with the rocks lowest in position, and thence proceeding upwards according to the succession of the strata. But there is no particular convenience in this case in adhering to the general rule; besides which, the history of the westernmost isles of this group will be far more intelligible by treating the whole in the order here followed.

The advantages of any particular order arise chiefly from its giving a fixed point of departure. This may sometimes be found as conveniently in the uppermost as in the lowermost rocks; while, independently of the reason above assigned, the connexion of Inish Capel and of Kerrera with Mull, renders it convenient to commence with those islands. Thus the chain of connexion with the continental land will be more easily preserved; a connexion which the claims of physical geography render it at all times desirable to maintain when possible.

INISH CAPEL.*

In proceeding to the particular description of the Schistose islands, I have thought proper to commence with Inish Capel, which, however insignificant in magnitude, is not so in a geological view; the comparative simplicity of its structure rendering it easily understood, while it forms a useful introduction to those which immediately follow, and present features more complicated. The exposure of the secondary strata which it displays, will induce a geologist to search for them in Seil where they might else escape his attention. It is not only on this occasion that a small spot presents to the observer the solution of difficulties with which he has been bewildered in the investigation of extensive tracts of country. He who shall commence the examination of the Schistose islands in the order in which they are here described, not in that in which they were examined, will find a smooth path before him instead of the intricate one which so often obstructed my own progress; and will perceive, at the beginning of his labours, that orderly arrangement which was only discovered at the end of mine.

The translated name of this spot, the Mare's island, has been improperly applied in the maps to the Garvelach isles: this island in the same maps being erroneously denominated the Sheep's isle. It lies about a mile north of the north-west angle of Seil, and is scarcely a mile in circumference, being surrounded by an abrupt rocky boundary of low cliffs. At its south-east angle, a succession of secondary strata appears at the water's edge. These dip towards the west, and in this respect they conform to the dip of the analogous strata already de-

* See the Map of the Slate isles.

scribed in many of the Trap islands to the northward. It will also hereafter be shown, that the rare and detached portions of secondary rocks which occur in Seil and on the adjoining mainland, present a corresponding inclination; which is here the reverse of that of the primary strata on which they lie, the dip of these being invariably to the eastward. The angle of inclination to the horizon seems here to be about fifteen or twenty degrees; but a boisterous sea breaking over the rock, prevented me from making any very accurate remarks on this unimportant part of the subject. The lowest bed at that time admitting of examination, was a gravelly conglomerate with an argillaceous base, including fragments of quartz. It is succeeded by beds of a red schistose sandstone, followed by others of a grey colour and more argillaceous composition. These beds are precisely similar to those that accompany the lowest red sandstone, to which they doubtless belong. If any primary strata are here to be found below them, they were concealed by the state of the tide and the high running of the swell.

Incumbent on these rocks is a mass of trap which constitutes the main bulk of the island; but as it occurs in abundance both in Kerrera and Seil, the description of its peculiar characters may be deferred.

It is evident from this brief account, that Inish Capel resembles in some measure the neighbouring parts of Mull, and it will hereafter be shown to correspond more exactly with Kerrera and the northern parts of Seil; forming a connecting link between the former and the two latter islands.

KERRERA.

THE island of Kerrera skirts the neighbouring coast of Argyllshire in a direction, as far as it extends, nearly parallel; being separated from it by a strait about half a mile in breadth, which affords excellent harbours for ships under any wind and weather. That known by the name of the Horseshoe, on the Kerrera side, is one of the most secure on this coast. This island is about four miles in length and two in breadth; its form being irregularly oval and but little indented by bays or diversified with headlands. At the northern extremity, it assists, with the small island called the Maiden's island, in forming the harbour of Oban; a part of the coast well known to mineralogists as well as tourists, and of which descriptions have often been published. Independently of its mineralogical interest, the neighbouring castles of Dunnolly and Dunstaffnage, and the more distant plain of the supposed Beregonium, give it a value in the eyes of the antiquary to whom the power of the former chieftains of Lorn is still an object of fond remembrance; while the grandeur of the mountain screen that encircles the Linnhe Loch, together with the scattered islands that diversify its wide expanse, render it equally attractive to the lover of picturesque beauty.

The reader who is acquainted with this coast, can scarcely fail to have taken some interest in the history of Dunstaffnage castle, and in that of the plain which is supposed to contain the remains of the very problematical, or rather, visionary Beregonium. Notwithstanding all that has been said on this subject, it does not appear that any ruins of buildings here exist to indicate

* See the Map of the Slate isles.

the position of a town. The vitrified fort of Dun mac Sniochain seems to be the only specimen of antiquity in this spot; and it is not impossible that some popular traditions respecting this work, may have given rise to the notion of a capital city having once existed here. Many parts of early Scottish history rest on fully as weak a foundation, and it would be an endless task to labour through all these fictions. Scotland had certainly no capital even down to the time of Robert the First, who died in 1329. Still less could the site of the capital of Scotland be in Argyll, as there never was a city in this district at any period of its history.

The antiquity of Dunstaffnage castle is not less problematical. Pennant, who speaks of its high antiquity, does not appear to have examined these subjects with the requisite discrimination, or he must have perceived that its date could not have been very distant. The Gothic arched doorway of hewn stone at the entrance, and other obvious circumstances in the structure of the building, point to a comparatively recent period. It is probably coeval with the castles of Duart, Dunnolly, Duntulm, and others of similar architecture, which were erected by the Highland chieftains after the Northmen had been expelled and they had acquired a separate independence. Castles of stone and lime were unknown before that period. It appears however that the Norwegians never possessed any sovereignty in this part of Argyllshire; although the Lords of Lorn were descended from Somerled, who was of Norwegian lineage. Dunstaffnage was probably erected by these chiefs, namely, the Macdougalls, before they were overwhelmed by the more recent power of the Campbells; although there is nothing in its structure to prevent it from having been the work of even the comparatively modern times of that family. This probability is further indicated by the superior refinement of its architecture to that of Dunnolly, the acknowledged seat of the Macdougalls. The Scottish kings

never resided in Lorn, and it is impossible therefore that it could have been a royal residence: that tradition seems to rest on testimony as unworthy of attention as the metropolitan claims of the plain of Beregonium. In the regal character of Dunstaffnage is involved a set of additional doubts respecting the fatal stone, said to have been carried from it to Scone by Kenneth the Second, and subsequently removed to Westminster Abbey by Edward. Respecting the real history of this talisman, it is now in vain to inquire; but the original transportation of Jacob's pillow to the wilds of Lorn, is not much more imaginary than the greater part of the history of Dunstaffnage.*

Although the coast outline of Kerrera is little marked by prominencies or indentations, the surface of the island is extremely irregular; being formed of numerous small hills separated by hollows, disposed in a manner so intricate as to render it a perfect labyrinth to a stranger, when excluded from a sight of the leading outline of the shores. In this respect it resembles the neighbouring coast of Argyllshire; the rugged outlines and graceless forms of which can scarcely fail to have impressed all those who have visited Oban or Dunstaffnage. It may be called, in the strictest sense, a hilly island, since it scarcely possesses a continuous acre of level land: the little that exists, is at the northern extremity. I obtained no measure of the greatest altitude, which is near the centre of the island, but conjecture that it does not fall short of 1200 feet. Abrupt faces of rock sometimes terminate these hills, and, as in most trap countries, they are found in the interior as frequently as on the sea coasts. At the southern extremity, these cliffs extend to the sea shore, in a variety of intricate and rugged forms well suited to the character of the

* The stone in question is a calcareous sandstone exactly resembling that which forms the doorway of Dunstaffnage castle.

boisterous sea that so often breaks against them; forming with it a dreary scene of wildness which is rendered more impressive by the ruins of the ancient castle of Gylen perched on a rocky cliff amid the contention of the winds and waters.

Although the soil of Kerrera is generally fertile, it is, from the irregularity and the steepness of the hills, principally devoted to pasturage, offering in most places an aspect of permanent verdure.

THE very disordered positions of the rocks of Kerrera, produce obscurities not easily elucidated in the island itself, but which are rendered clear by an examination of the neighbouring mainland; a tract in itself sufficiently interesting and intricate to claim much of the attention of a geologist.

In examining the island it is convenient to commence from the clay slate, on account of the very discontinuous and unconnected state in which the sandstone appears, and the impossibility of tracing its detached portions by any other clue than that of their proximity to this rock. The confusion which will be apparent, will, I trust, prove to be that of nature, not that of the observations; being only one, out of many instances, of those irregularities in the positions of strata, so common where trap rocks form a principal part of the structure of a country.*

However difficult it may be to trace a continuous extent of argillaceous schist throughout Kerrera, it is not difficult to perceive that it is the lowest rock. It may be observed in many places along the shore, but not along the whole of it; the secondary strata occupying some parts, and the superincumbent trap descending so deep in others, as to conceal from view that which lies

* Plate XVI. fig. 3.

beneath.* This schist is also found occupying some of the hills in the interior, even at a considerable elevation; but is so covered with soil, and intermixed with other hills of trap and conglomerate, that it is impossible to conjecture the nature and extent of its disposition in those places. On the shores however, although its regularity is by no means so absolute as in the islands to the southward, the general bearing of the elevated edges of the beds is north-easterly or nearly so; a direction which will be found to correspond very accurately with that of the strata in many of the isles to the southward. The dip is also invariably the same as in those, or easterly; the angle of elevation however, varying much more than it does in any of the islands where trap does not occur, and being never properly assignable. Beds of a coarser slate are found alternating with the finer clay slate, and possessing the well known characters of graywacké; an alternation which is also to be found in the neighbouring islands of Seil and Luing.

The character of the clay slate is identical with that of Seil and of Eysdill so well known in commerce, and it is therefore superfluous to describe it. That of the graywacké slate is equally familiar; I need only say that it is of a fine texture and marked by scales of mica interspersed among the laminæ. At the points of junction with the trap, whether overlying or in veins, both these schists are generally harder than elsewhere; while they are at the same time contorted, and easily broken into fragments less regular and much more minute than at a distance from those places. The action of the

* With respect to the accompanying map I must observe, that it does not pretend to give a detail of the rocks, since that would, on any admissible scale, be impossible, on account of their extreme irregularity and minute admixture. It points out one or two of the most conspicuous portions of the strata; the overlying trap necessarily occupying the chief parts of the surface.

atmosphere is also much more remarkable on them near these junctions; since they are almost always found to be rotten to a considerable depth.

The clay slate is here, as in other situations, interspersed with cubic crystals of pyrites, often of a large size. In the vicinity of one of the junctions, a peculiar appearance occurs, the chemical explanation of which is not very obvious. The cavities formerly occupied by the crystals, are occasionally filled with a very fine black powder, which on analysis, was found to consist of sulphur mixed with the black oxide of iron.

The next rock to be noticed in the order of succession, is placed here, not solely on theoretical views, but because it is actually found in contact with the clay slate not far from the ferry house. It is however very limited in extent, nor does it necessarily follow the schist; since it is more common to find that rock immediately succeeded by the sandstone or by the conglomerate hereafter to be described. The substance in question is formed of fragments of schist of different colours, cemented by a base of the same materials more minutely divided. A similar rock is not uncommon between the schist and the ordinary sandstone conglomerate in other places. It is impossible to give any further account of its position or extent, as it is too limited to admit of accurate investigation.

To this succeeds in order, that rock which, from its peculiarity of structure and irregularity of position, is the most difficult circumstance to explain in the composition of the island. It appears under the ordinary characters of a fine sandstone and of a conglomerate; and, from its great extent on the adjoining mainland, in a track much frequented by travellers, is so generally known that, to many, an account of its characters will perhaps be superfluous. It is too important however to pass by unnoticed, even at the hazard of detailing that which

may possibly be as well known to the reader as to the writer of this description.

The simplest and most ordinary substance in this series is a red schistose sandstone, resembling that which occurs among the multiform beds of the lowest red sandstone in this country. With others, I was at first inclined to suppose that this alone was the usual red sandstone; and that it was distinct from the grey sandstone and conglomerate that follow it, which have been considered as local rocks dependent on the trap; though not inclined, with those observers, to consider this rock a trap tuff, as such local conglomerates have been called. That opinion is erroneous and the distinction unfounded; the whole series, whether red or grey, fine or conglomerated, bearing a rigid analogy to the common red sandstone series of other places; differing from it only in composition, in consequence of the peculiar nature of the original rocks from which it has been formed.

The red portion differs in no respect from the most common varieties of this rock, consisting of quartz with an admixture of red ferruginous clay and mica; occasionally also containing undecomposed grains of felspar. Though it immediately succeeds the schist in some places, in others it alternates with the grey sandstone in such a manner that this occasionally becomes the lowest in position. It forms beds of variable thickness, sometimes, as above remarked, tending to the schistose structure, at others very massive; occasionally of a fine texture, in other places gravelly, and in many, presenting the conglomerate character in a very striking manner, from the great size of the imbedded fragments. These several varieties are every where intermixed, as is usual in the red sandstone; the one succeeding the other without any regular order, and even the individual bed varying in the course of its lateral progress. In all cases however, the base of the conglomerate is the same as the fine sandstone, the differences

consisting only in the variety, number, or magnitude of the imbedded pebbles and fragments.

The grey sandstone is fundamentally composed of grains of clinkstone or compact felspar of different colours; namely, of the basis of those traps which constitute the present superincumbent strata of the adjacent country. A mixture of hornblende, quartz, mica, and occasionally of calcareous matter with clay, vary its aspect without causing any material change in its fundamental character.

The substances imbedded in this base when it passes to the state of conglomerate, are various; more so than in any other rock of similar structure that has fallen under my examination in Scotland. Granite and quartz, of different colours and textures, are among the most conspicuous, since they are among the most durable materials. But the peculiarity here remarkable, is the great number of imbedded pebbles of the various trap rocks; by which it is no less distinguishable than by the composition of its base. These pebbles present every possible variety; namely, basalt, greenstone, amygdaloids, cavernous trap, and clinkstone or compact felspar; together with those porphyritic or other modifications that are found in nature associated with the other rocks of this extensive family. Their size is extremely various, and frequently enormous; and as they are often scattered in abundance on the shores and on the surface of the land, they are sometimes readily mistaken for transported alluvia, detached from their original rocks without having undergone this intermediate state of transmigration.

Although the geological position of these strata is that of immediate superposition to the argillaceous schist, their local position is often so intricate and so difficult to comprehend, that the order of their arrangement cannot be conjectured without much patient research; a circumstance in which this rock differs from that which usually separates the primary and secondary strata; the position of this being commonly as regular as those

of the strata that precede and follow it. The origin of this confusion must be sought in those causes which so often affect the regularity of stratified rocks where extensive masses or numerous veins of trap occur.

It will often appear on examination, that the conglomerate lies above the simple trap as well as below it; and perhaps this order does actually take place. If it is sometimes seen lying below the clay slate, it will, I doubt not, be found that this is a deception arising from the mechanical derangement of the respective rocks; and that superior altitude is not in this case a test of superior position. It is a remarkable proof of such derangement, that the highest summit of the island is formed of conglomerate accompanied laterally by hills of clay slate little less elevated; while again, on the shore, and particularly at the south-western end of the island, the same rock presents a remarkably regular series of beds not materially deviating from the horizontal position. These regular beds dip toward the west wherever they can be examined; and they are therefore here, as in Inish Capel, placed in a reverse position to the primary strata. The same is true of those partially exposed masses of red sandstone which are found on the adjacent mainland. But the considerations arising out of this must be deferred to a more proper place.

I must not however quit this subject without stating the reasons for supposing that the conglomerate and sandstone series of Kerrera and the neighbouring shore, is analogous to that which, in the other parts of this country, separates the primary from the secondary strata. The only differences indeed, are its broken and interrupted position, and the nature of its materials. The peculiarity of position is partly to be accounted for by the ordinary waste which all rocks undergo, according to their several degrees of tenacity and exposure; and partly, perhaps still more, by the great number of trap veins which traverse it, and the great extent of overlying

trap with which it is connected. With respect to composition I may remark, that in general, perhaps in all cases, the conglomerates partake of the different older rocks next to which they lie; containing fragments of all these, or at least of all such as have had sufficient durability to survive the mechanical attrition they have undergone before they were consolidated into one mass. Thus a given line of conglomerate, however continuous it may be as a bed, will vary in its composition as the rocks on which it lies in different places, change their characters; and for the truth of this remark I may refer to the different parts of the great conglomerate line of Scotland, where differences of this nature actually occur. In the case of the Kerrera rock, it is easy to conceive, that the conglomerate has been formed during those revolutions of the surface that produced the whole of this substance wherever it is found, and in the vicinity of those trap rocks which constitute so remarkable a feature in this country. Hence it has necessarily partaken of their nature; while it includes, at the same time, fragments of granite and quartz, of an origin more distant, and more susceptible of transportation without injury. One remark of an important nature, but similar to that deduced from the structure of Canna, may be derived from the nature of the rocks now described. Two distinct formations of trap are indicated by its composition and situation; one prior to the deposition of the conglomerate, and one posterior; the former being the source of the fragments it contains, and the other now overlying and intersecting the beds. The independent veins hereafter described are, equally, proofs of a third.

With respect to the two latter classes of this trap, there is nothing remarkable in this particular instance; as analogous proofs of two formations of trap have in various cases come under review throughout this work. The former deserves a separate consideration; since the evidence derived from the structure of Canna, does not

extend so far, and is not followed by the same consequences which here arise from the existence of fragments of trap in the conglomerate rocks. It has been shown that the conglomerates of that island are of a local nature, and peculiarly connected with a succession of partial deposits of trap rocks. But it has been proved, that in the island now under review and on the adjoining continent, the conglomerate is part of the extensive deposit which separates the primary from the secondary rocks; or that at least it is analogous to this, and equally to be considered as the first in order of the general series of these latter. It therefore follows that the fragments of trap existing in this rock have, like the other substances, been derived from previous masses of that rock of a date prior to the deposition of the secondary strata, and equally therefore to be ranked with the other primary strata, by the fragments of which it is accompanied.

It may be deduced from many parts of this work, that the trap rocks are usually associated with the secondary strata, and are, in by far the predominant examples, superior to them; while the instances in which they occur in union with, or immediate superposition to, the primary, are comparatively rare. Even in Morven, where extensive masses of these rocks are found in immediate contact with gneiss in some places, the existence of intermediate fragments of secondary strata prove that the whole deposit is of a date posterior to these, and that it is only incidentally and occasionally connected with the primary rocks. The remarks formerly made in the description of Sky, also show that such a state of immediate superposition and contact is no proof of an original connexion in point of time; as the peculiar mode in which this rock appears to have been deposited, enables it to possess an intimate connexion with every rock from the most ancient to the most recent. Under these circumstances, of its predominant connexion with the secondary strata, and of the absence of positive proof

of any original connexion with the primary previously to the deposition of those, it might be concluded that it was universally posterior to the secondary rocks; and that as granite is the unstratified rock which peculiarly interferes with the primary strata, so trap was the intruding substance in the secondary. From the present fact it is however evident, that there have been masses of trap, similar to the most recent in every circumstance of structure and composition, but of a date prior to that of the secondary rocks; and it offers perhaps the only unquestionable species of evidence on that subject which can be obtained. It will still always remain uncertain, unless where similar circumstances can be proved, whether the trap rocks now actually found in conjunction with the primary strata, are of primary or secondary date; as alternation affords no evidence of consecutive formation, in the case of rocks which possess the intruding character. Other characters from whence such evidence may be derived, may possibly hereafter be discovered; and the subject is thus pointed out to geologists as one of the numerous important circumstances still required in the general history, not only of this particular family, but of the science itself.

In the present case it became a natural object of inquiry whether the trap of Appin, which is conterminous with the granite of Loch Etive, might not have been the source of the nodules in question. The examination of this tract however, proved, that it was associated with beds of conglomerate containing fragments similar to those of the sandstone of Oban and of the island under review; and that it was therefore in every respect to be considered as a portion of the general trap district of Mull and Lorn.

In concluding I may remark, that the rarity of trap rocks among those of the primary class, presuming that they have actually existed in this period as in the secondary, may be explained from the great facility of

decomposition which they evidently possess. That facility is marked by the enormous waste they have experienced in those cases where they are obviously of a very recent date, of which innumerable examples have been pointed out in these islands; nor is it difficult to conceive, that, through a period of infinitely longer duration, the greater number, or the whole of these rocks, should have disappeared in those instances where their formation has preceded that of the secondary rocks. The peculiar circumstances which attend the overlying rocks now connected with granite, such as those of Glenco and the adjoining districts, of which the character is generally porphyritic, although occasionally not distinguishable from the more recent traps, indicate these as being in all probability the remains of trap deposits which may be considered as of the primary class, and as the last remains of masses once more extensive. That tract is not distant from the spot under review; and under former circumstances, of greater extent, and of greater variety of composition, may have been the source of the nodules in the conglomerate of Oban which has given rise to this discussion.

The last rock that remains to be described in Kerrera is the trap, which, if not absolutely and always uppermost, presents sufficient indications of its posteriority to all the other rocks. Till a new classification of these rocks is adopted, I am compelled to use this general term; although it here presents varieties much in want of more distinctive appellations. It is recognised at a distance by the total absence of stratification, and by the vertical fracture which its precipitous faces every where display.

As in other cases, the different modifications or members are here found gradually changing their characters and passing into each other. Thus greenstone passes into basalt, or into clinkstone, or compact felspar, or into porphyries and amygdaloids of various aspects. Many

of the simpler varieties occur, of a brown, grey, reddish, or white colour, with different degrees of hardness and much diversity of fracture; offering specimens, to none of which, in the present state of our nomenclature, it is possible to apply names that could be understood. It is perhaps better to leave such substances without a name, than to designate them by terms that have been already too often used in a lax and ambiguous sense; since the negative confusion that may result from the want of appropriate appellations, is much less inconvenient than the positive one which attends their misapplication; inasmuch as it admits of future amendment, and as it is much easier to add to a nomenclature than to change its signification. Zeolites, calcareous spar, and green earth, occur in the amygdaloids, but the most remarkable variety is found at the south-western part of the island. This is amygdaloidal and of a somewhat earthy texture, the base being harder than common claystone. Together with calcareous spar, it contains a large proportion of brown mica; some of which is perfectly crystallized in hexagonal plates attaining a quarter of an inch in diameter. This rock is brown, but weathers to a dark red, and assumes irregularly columnar forms.

If the connexions of these rocks with those on which they lie are examined, it will be found that they are sometimes in contact with the clay slate, at others with the graywacké, a proof of their posteriority to both, and of their irregularity of position. They are also found branching into large veins, which again ramify into smaller; penetrating the schist in various directions, and sometimes for a long space conformable to its disposition. Where these parts only are visible, and where their connexion with the superincumbent masses cannot be traced, they have the appearance of beds alternating with the schist; but this appearance, traced in one instance to its true origin, justifies us in assigning the same to all similar masses.

The relation of the trap to the sandstone and conglomerate, is by no means so clear; yet as some decided instances occur of its overlying position with respect to these also, we are perhaps justified in concluding, that the whole of the trap is posterior to the stratified rocks whether primary or secondary; and that wherever it appears inferior to the latter, the apparent priority implied by this, is only an example of intrusion similar to that which occurs between the trap and the schists.

The confusion naturally attending this rock, is much increased by the great number of trap veins which are independent of these ramifications and of the principal masses; and which are proved to be so by their passing through the trap as well as the stratified rocks in an uninterrupted course; having the ordinary characters of the usual veins so frequent throughout Scotland, and so prevalent in the vicinity of the great masses that constitute Sky, Mull, and the associated islands. Their posteriority to the masses of trap is in some cases distinctly seen; although in many, when they are similar in character and composition to the rock they traverse, it is difficult to distinguish them from those which are only branches of the mass; since, from weathering in the same manner, their most ordinary and obvious distinguishing characters are obscured.

The variety of composition that occurs in the trap veins, is considerable; and it is remarkable, that both here and in the neighbouring islands where they also occur, their characters are often unusual; partaking of those of the larger masses in the neighbourhood, and consisting of the several varieties of compact felspar or clinkstone * which compose these, rather than of the greenstones and basalts of which they are more generally formed in other places. It is probable, that in as far as they are formed

* I have not attempted, in the account of this island, to assign the exact name to this rock, because it appears to be often of an intermediate character.

of these substances, they are actually portions of the neighbouring masses and not independent veins, and that if they could be thoroughly traced, they would be found to terminate in them. But as I shall have occasion shortly to re-examine this subject in the other schistose islands where the same substances occur, I shall here terminate the account of the rocks of Kerrera.

It only remains to enumerate two minerals that I observed here, both of them being more remarkable for the circumstances under which they occur than for their rarity.

The first of these is red stilbite, which is found occupying the fissures of graywacké schist in the vicinity of a trap vein. The specimens are neither large nor decidedly crystallized, yet they admit of no doubt respecting the nature of the mineral.

The next is heliotrope, which is found on the shore in fragments and nodules that appear, from their forms, to have been detached from the conglomerate rock. It is possible that this mineral, being an inmate of trap, may exist here in that rock; but I did not find it in that situation. It is more probable that it appertained to the original rock, from the ruins of which the conglomerate was formed; and if it cannot thus lay claim to Kerrera as its native place, it adds one more to the localities which I have on different occasions recorded, of a substance once esteemed rare.

SEIL.*

This island has the next claim on description, no less from its position than from the identity of a considerable part of its structure with that of Kerrera; in consequence of which it forms the second stage of transition between the Trap islands and those which are to follow, from which trap, except in the form of veins, is excluded.

It is divided from the mainland by a narrow strait nearly two miles in length, rarely exceeding 200 yards in breadth, and narrowing for a considerable space to one of fifty or sixty feet. The stream of tide running with considerable velocity through this passage, assumes the appearance of an inland river, unless when the rocks skirted at low water with sea weed, betray its marine connexions. The land on each side being high and rocky, and sprinkled with wood, the scene is no less picturesque than singular. The water is here sufficiently deep at half tide to admit the passage of the boats of the country; while the communication between the island and the opposite shore, is maintained by a bridge of one arch of considerable span; as yet a solitary instance in Britain of such a structure uniting an island to the main. Not only here, but throughout the whole complicated strait which separates Torsa, Luing, Shuna, and Seil, from each other, and from the mainland, scenes of the most entertaining class of picturesque beauty occur. The islands, in endless variety of form, are washed by winding seas and diversified with rocks and wood, while they are enlivened by human habitations, improved cultivation, and by the countless boats and ships that navigate these

* Seil, a sail, (Danish). Names derived from ships are here very common; and hence also Longa, Lunga, Luing, from the Gaelic Lung, a ship; and Flodda, Flota, from the Danish Flode, a fleet.

straits; the varied mountains of Mull, and of the Appin and Morven lands, rising blue in the distance.

Seil is about three miles in length and two in breadth, but of a very irregular shape; protruding in long points parallel to its two principal boundaries. It is naturally divided into three ridges, separated by two vallies in the same parallel direction; and as these ridges coincide with the geological disposition of its rocks, on which indeed they depend, they afford a useful guide in describing or investigating its structure. The northernmost is the most elevated and the most rugged, rising to a height apparently exceeding 800 feet, and presenting to the sea, on that side of the island, a series of naked precipices. The second, or middle ridge, is scarcely half as high, and is prolonged more decidedly than the former in a north-easterly direction; presenting, in many parts, faces of bare rock, yet descending to the sea at each end by flat and verdant shores. A second valley divides it from the last ridge, which is low and narrow, and reaches also in the same direction from sea to sea; being characterized, even at a distance, by its grey colour and by the bare rocks that protrude along the whole of its course. At its eastern side a flat shore succeeds; much indented, but verdant and fertile; as is the greater part of the island wherever the form of the ground admits of cultivation. The section of the rocks which accompanies this description will also convey an adequate idea of the form of the land. In describing them I shall follow the order adopted in Kerrera.

The section will show,* that the lowest rock is clay slate, the extent of which is such as to occupy the larger part of the island. At the north-western side, but a small portion of that substance is however to be

* Plate XXI. fig. 1.

observed, skirting some of the shores and surmounted by the trap of that ridge; the subjoined sketch being consequently deduced from its position, and from general considerations. It is indeed possible that some of the beds of rock, which here, as in other places, alternate with clay slate, may exist in lieu of that which I have supposed to occupy the whole. If so, however, they must be very peculiarly placed, as between Eysdill and the bottom of the sinuosity which looks to the south-west, the edges of almost all the beds of schist that occupy the tract surmounted by the trap, are accessible. The direction of these beds, as determined by that of their elevated edges, is N. E. by N.; a bearing which corresponds to those of the leading ridges as well as to the outlines of the island, and is very evidently the cause of both. The dip also is easterly, and in both these circumstances the strata of Seil correspond with those of Kerrera, as far as the latter admit of comparison; and more exactly still with those of many of the islands of this division hereafter to be described. The quantity of the inclination is here, as every where else, inconstant; ranging in a general way from twenty to fifty degrees.

The mineral character of this rock is too well known to require description, since, like the schist of Kerrera, it is identical with that so largely quarried in the adjoining island of Eysdill, which is in fact but a detached portion of these very strata. The peculiarities which it presents are here passed over, because they are noticed in some other of the numerous situations in which it occurs.

Two substances sufficiently distinct in mineral character from common clay slate, are here found interstratified with it, but, as far as I saw, in very inferior quantity. One of them is an argillaceous schist slate highly charged with minute particles of quartz, so as almost to resemble a sandstone, and, like some of these, crumbling under the hands into a blueish sand. The other is a perfect gray-

wacké schist, capable of being raised in coarse slates, and scarcely distinguishable from that of Cumberland. It is not however quarried, the manufactures of slates, in which this island abounds, being solely occupied on the finer schist. The quarries of Seil, like those of Eysdill, have long been known, and their produce is the subject of a very extended commerce.

The lowermost beds of clay slate thus described, constitute the middle ridge of the island. In arriving at the third ridge, which lies to the eastward of this, a different set of strata is seen, conformable to these in position and direction, and, of course, immediately following them in the order of superposition. These rocks are conspicuous at a distance, not only from their grey colour, but from their unfriendliness to vegetation; in consequence of which they are seen protruding at the surface almost throughout their whole extent. Besides their common division by parallel seams, a portion of them is split into prismatic forms at right angles to the beds, and thus attract notice at a considerable distance among the darker rocks and more verdant clothing of the clay slate.

The most remarkable beds in this collection of strata, consist of a mixture of pale grey compact felspar with a greenish hornblende, extremely tough under the hammer. This rock is of a light grey colour, and to its peculiar fracture the prismatic aspect of the whole is owing. It will be found to exist in many places hereafter to be described, in a situation and with connexions similar to those which it here possesses. That it may not be supposed a member of the trap family, with which it is associated in composition, it is necessary to say that the beds are regularly interstratified with the surrounding rocks; in which respect it differs materially even from those masses of trap that are occasionally found interposed among stratified rocks so as often to put on the deceptive appearance of true strata. It must be considered a member of a peculiar series, in which chlorite and hornblende schists are the

predominant substances, and which will hereafter be described at length in the account of the Craignish islands, and in the general concluding remarks. To avoid all ambiguity, I have preferred leaving it unnamed, to the use of the term greenstone; a name not very well applied on many occasions, and often in danger of exciting an improper association of ideas respecting geological relations.

The rocks which accompany this and form the remainder of the grey ridge, are a schistose and a compact quartz rock, with micaceous schist, and more rarely, chlorite schist; all of these being members of the series above mentioned, and therefore to be examined in greater detail hereafter, when their connexions will admit of a more ample description.

The next rock in the order of superposition, and consequently, eastward, is the same clay slate that occurs in the lowest position to the westward; and it here forms the whole remaining portion of the island. As it differs from the former in no respect, it requires no description; and I need only add that, like those beds, it is extensively wrought for roofing slate.

It is evident then that the clay slate alternates with the other schistose rocks; an appearance very extensively confirmed, not merely by the comparison of the positions of the strata in different islands, but by their actual alternations in many other places. However much this observation may differ from those of others respecting the natural affinities of clay slate, it can only be said that it is a faithful record of the appearances.

The last of the stratified rocks to be seen in Seil, occurs but in small quantity, and is found on the north-western side of the island. It is a portion of the secondary strata already described in Kerrera and Inish Capel, but is neither extensive nor remarkable enough to require a more detailed record. Its existence suffices to establish the general continuity of character among these three islands, no less than the respective resemblance of the

schistose rocks and of the trap which form their most conspicuous features.

It is not necessary to describe the trap in great detail, after the account already given of Kerrera; to the corresponding rocks of which it not only bears a striking resemblance, but of which it may be said to form a detached portion. As far as can be discovered, it is every where incumbent on the conglomerate and schist, as in that island; the junction being also often attended by ramifying veins. It breaks into bare precipices with an irregularly prismatic fracture, and is thence easily distinguished at a distance, from the rocks that constitute the remainder of the island. The predominant substance appears, as in Kerrera, to be a compact felspar, generally very brittle though hard, and breaking with great violence into sharp fragments. It has sometimes a laminar tendency; a circumstance attending the rocks of this tribe, which will again be noticed more particularly when Arran shall come under review. Occasionally also it contains a crystal of felspar or a minute nodule of zeolite; thus marking the first approaches to the porphyritic and to the amygdaloidal characters. It varies much in colour, being grey, brown, brownish purple, and dark lead blue; and in one case the brown varieties were found reticulated, after exposure to the air, with extremely minute white lines, although these were invisible in the fresh fracture.

Veins of the same material are abundant in the island, and they present the same ambiguity of disposition as those of Kerrera. It is sufficient to say that they occupy every possible direction, either conforming to the strata or traversing them. But the conclusions to be drawn from these appearances have been already generally stated under the account of Kerrera, and will be more usefully detailed in describing Torsa, where they occur with greater distinctness. I shall here notice a few only that present remarkable features.

One of these is a vein of well characterized black basalt,

containing a few scattered crystals of glassy felspar, so transparent as to permit the colour of the stone to shine through them. Veins of such perfect basalt are very uncommon in these islands. A much more common class of veins here, consists of a grey compact felspar, weathering first to brown and subsequently to white; an appearance described hereafter under some detail in Torsa, where it is equally or more conspicuous. A few are to be seen, consisting of a tolerably pure white and opake compact felspar, being similar to those which occur in the neighbouring islands. One was observed, consisting of a blueish grey claystone weathering into a greenish brown, and containing minute black earthy spots together with a few irregular crystals of felspar. But it would be endless to enumerate all these varieties, and I shall therefore conclude the description of Seil with an account of one that is remarkable chiefly from its connexion with the including rock.* It is found close to the town, and consists of a pale grey compact felspar passing to claystone, holding a course considerably erect, yet parallel to the clay slate, which is here placed at a high angle. At each side it is intermixed to the depth of an inch or two, with distinct fragments of the schist in which it lies; their characters being in no way different from those of the rock whence they have been derived. I need not stop to deduce any of the more ordinary conclusions so often drawn from similar appearances: it is here more important to point out the confirmation which this adds to the opinion already stated, and supported by other phenomena, namely, that such rocks are truly veins even where they are parallel to the strata; and to suggest the analogy which they bear to those mineral veins of which the outer surfaces are formed from the fragments of the including rocks.

It is nevertheless not unimportant here to remark, that although the existence of fragments of schists among

* Plate XXI. fig. 4.

masses of trap, as well as in the veins of that substance, has been noticed in various parts of this work, there is in one respect an important distinction between these two cases. In the veins, as in the instance under review, it appears that the intrusion of the fluid mass has merely produced the effect of mechanically displacing, and consequently of entangling, the fragments of the adjoining strata. Such fragments are often little changed in aspect, while in other cases they undergo material alterations; these variations apparently depending on differences in the condition of the intruding material which are not difficult to conceive. But where the fragments of schist are found in the larger masses of this rock, they present a very different appearance; undergoing those gradual changes which mark the commencement of fusion; and even the same fragment, in some instances, offering an example of each substance; the trap and the schist being connected by an uninterrupted gradation. It is easy to understand how the latter effect should have resulted from the greater bulk of the fused material, or from a termination of the process of fusion in any given mass of schist, before the whole change was completed.

From the circumstances detailed in the description of Sky, it has also appeared that the shales of the secondary strata have been in many cases subjected to this process; thus at times producing stratified rocks resembling basalt, and, at others, being in all probability completely converted into amorphous masses of this or of the analogous substances. From this latter event may be explained a circumstance peculiar to the trap rocks, and although but occasionally found, strongly distinguishing them from all the other rocks which do not contain organic substances. This is the existence of carbon, or of charcoal under some form, in their composition; a fact observed by chemists. It is easy to imagine that in this case the trap has probably originated in bituminous shale, or in other secondary strata containing carbonaceous and organic

matter. The existence of bituminous matter in crystalline limestones is no objection to this view; but rather tends to confirm it; as there is little doubt that these also are portions of conchiferous beds which have undergone essential changes of structure; losing the forms of the bodies which they contained, but preserving a portion at least, of the constituent ingredients.

There is nothing to add respecting the small island of Eysdill, which may be considered, geologically, as forming a portion of Seil, being separated from it by a very narrow strait. The reputation of its slate quarries is far spread, and its features present nothing which has not been already stated in considering the principal island.

I may terminate this account of Seil by remarking that some detached islets at its northern extremity consist of trap, as is indicated in the map that illustrates this description.

LUING.*

THIS island, associated with Seil by community of external character and of position, as well as by geological structure, is separated from it by an arm of sea scarcely 300 yards in breadth. It possesses similar relations to Torsa and Shuna; the whole forming a group which combines with variety and intricacy, an extensive range of picturesque and pleasing maritime scenery. The shore is in general low, and the surface diversified with rocky eminences, which often form interior cliffs of moderate altitude. These prevail chiefly in the northern half of the island; a considerable degree of cultivation being found in the intervals, fostered by the large population, which here, as in Seil, is employed in the manufacture of Slates.†

* See the map of the Slate isles. The section of Seil is equally applicable to Luing, omitting the trap only, as will appear by comparing the lines of bearing in the map.

† The well known aversion of the Highlanders to steady labour is such, that in Sky and in many other places, they cannot be employed in quarrying; for which purpose it has always been necessary to import labourers from the low country. In this tract, bordering, comparatively, on the Lowlands, that indolence has in a great measure given way to industrious habits; a proof that the same may in time be effected elsewhere.

This disposition may be presumed to arise in some degree from habits acquired in tending cattle among the unenclosed corn; an occupation in which the children are employed from an early age. A singular and somewhat ludicrous example of it occurred recently, and I doubt not that it will long remain to amuse future travellers. The house of a small tenant lay across the intended line of a new road, which was accordingly carried through it. Being of sufficient length to accommodate the road and the inmates also, according to their notions of accommodation, the proprietor was content to build a wall at each of the separated ends, regardless of this Highland mode of ejectment; the rafters and thatch continuing to dangle above the road. A southern traveller may perhaps imagine that this house proves something more than Highland indolence.

The southern extremity of Luing is low, but never absolutely flat, and the highest ridge at the northern end seems scarcely to exceed 600 or 700 feet. There is in this part of the island a slight tendency to the formation of two distinct ridges, originating in the same cause as that mentioned in Seil, namely, the different nature of the rocky strata; but it is far less conspicuous, and would perhaps, but for the previous view of that spot, scarcely attract notice. It has been remarked that all the strata of Seil lie in a very even direction from S. W. by S. to N. E. by N. The same disposition exists at the northern end of Luing, as well as in the intermediate island of Torsa. At the southern extremity of the island however, this direction changes; and the elevated edges of the strata are there found lying on the north line of the compass, or somewhat more easterly. It will be seen in the map that the outline of the land corresponds with these different directions of the strata. There is consequently a curvature or a fracture of the strata somewhere towards the middle of the island; but I know not that it is possible to discover the point at which that takes place, or to determine to which of those two causes the change of direction is owing. Whatever it be, the difference is not great, as it scarcely exceeds two points of the compass; in strictness perhaps, twenty-six or twenty-eight degrees. From general experience it may be concluded, that the change in question consists in a curvature of the strata; and the circumstance, in itself sufficiently common, is only rendered interesting here, because, as will hereafter appear, most of the islands of this division are disposed with tolerable exactness in one or other of these directions; while in none, except in this, in Shuna, and in Jura, are both found united. If the point at which it might be seen has merely been overlooked, these remarks will direct future observers to the place where it is to be sought.

Whatever be the direction, the dip of the strata here, as throughout the whole group, is to the eastward; the

elevations varying considerably, but generally, as far as I could perceive, occupying high angles, namely, from fifty to eighty degrees. In some places nevertheless, and particularly on the eastern shore, they diminish, and the angles of twenty, thirty, and forty degrees, very commonly found in this group of islands, become the prevailing.

The mass of this island consists of clay slate, exactly similar to that of Seil and of Kerrera; being an obvious prolongation of the beds that constitute the former. It is unnecessary to enter into its mineral description except where any peculiarities occur: these will be noticed here; many of the appearances equally common to Seil having been referred to this place, on account of their greater conspicuity or facility of access. But it is first necessary to point out the alternations of the strata as far as any differences are found in them.

The westernmost, and therefore the lowest rocks, consist of the clay slate already described, alternating with the same sandy schist and graywacké already mentioned in Seil, and disposed in a manner so perfectly similar that the one is a mere repetition of the other; it should rather be said that they are but different portions of one line of strata. If the line of grey rock, which, in Seil, follows next to the western portion of the slate in the order of superposition, be also prolonged, it will be found equally to follow the clay slate in Luing; rising into that ridge which forms the most considerable elevation in the island.*

The external aspect of this rock, the mode of weathering,

* On the highest part of this ridge, the remains of one of those forts commonly considered of Danish origin are still to be seen, and in a state of tolerable integrity as far as its figure is concerned; the walls having only subsided into a ridge of loose stones. It is of an elliptical figure, about twenty yards by fifteen in its relative diameters, and, from the large quantity of materials in the work, the walls must have been of considerable thickness.

its natural division into prismatic fragments, and the strata that accompany it, resemble in every point those circumstances as they occur in the corresponding ridge in Seil, and, for the same reasons, it is here unnecessary to dwell on them. This series does not extend throughout the whole island, but terminates towards the middle, where the high grounds subside into the lower tract, and apparently where the change of direction in the strata takes place.

This collection of strata is also followed, as in Seil, by clay slate; the beds above it having generally also a lower elevation than those below. In this portion of the clay slate one of the principal varieties is found; and it is most abundant at the southern extremity of the island. This consists in the passage of the ordinary clay slate into drawing slate; a circumstance which also occurs, even more abundantly, in Torsa. This substance rarely, if ever, acquires the degree of softness which characterizes real specimens of that mineral; but many parts are sufficiently tender to leave their trace on paper. It occasionally contains mica, and pyrites, but the latter is much more rare than in the ordinary schist.

Among the beds now described are found thin strata of black and of grey limestone, intermingled and alternating with them in the manner usual with those limestones which occur among the schistose rocks. In colour, and indeed in general aspect, the two are sometimes not to be distinguished, so that on a cursory view the calcareous rock might be easily overlooked. These beds terminate the island in an eastern direction; being succeeded by the narrow strait that separates it from Shuna. In a geological view however, the strata of this island must be considered as succeeding those of Luing; the dip and direction being as regular and uniform as they will hereafter be found throughout all the islands connected with the Argyllshire coast, as well as in the mainland itself.

I must now take notice of two circumstances connected with this clay slate, which were deferred in describing the former islands, because the examples are most conspicuous here: they both relate to the fissile tendency of this rock.

Among the ordinary beds are to be seen irregular roundish masses of the same substance, but entirely void of fissile tendency. Being tougher and more durable, they resist the action of the sea longer than the strata in which they lie; and are therefore often found protruding from the rocks on the shore. Wherever they occur, the laminæ of the ordinary schist become incurvated round them, quitting their naturally straight direction. A circumstance resembling this, is by no means uncommon in gneiss, where concretions of hornblende rock are thus found surrounded by the laminæ of that substance; an instance of which was described in treating of Coll. It also happens in micaceous schist, the nodule in this case consisting of quartz. I must add that in the instance now described, the nodule bears no marks of attrition, nor any resemblance to an intruding substance previously formed. I know not if it must be considered as an example of the concretionary structure, or merely as a mechanical arrangement of the yielding laminæ of the slate over a previously indurated substance. It is rendered interesting, no less by its connexion with the obscure subject of contortion in rocks, than by its resemblance to the equally obscure structure of those schists which contain grains of quartz surrounded by mica conforming to them; but like many other facts, the explanation must be referred to a future increase of knowledge on those subjects.

It happens generally in these islands, that the fissile tendency of the clay slate is parallel to the beds; their boundaries or surfaces being determined by their alternations with other substances. These alternations appear to be often the only criterion by which we can distinguish

between the bed and the laminar disposition; but as this subject will be examined more fully hereafter when more difficult cases occur, I shall not now dwell on the distinction, but simply state it as the test here used in distinguishing the fissility from the stratification. Although both of these are thus generally conformable in this place, the lamination, in some cases, lies obliquely to the stratum; that obliquity being however but small; whereas in Isla, as I shall hereafter show, it forms a very considerable angle with the plane of the bed. This circumstance, like the former, is attended with some obscurity; since, in some cases, the lamination of the slate would appear to be the mere result of its mode of deposition, while in others it must necessarily have arisen from a concretionary arrangement. It is doubtless more simple to consider the fissile direction as in all cases the consequence of the latter cause, than to assume both as having acted on different occasions; but it by no means follows that the simplest solution is the true one; since, in the more recent schistose substances that contain organic remains, the position of those would often seem to indicate that this tendency is the consequence of the mechanical arrangement. In a few places, the laminæ of the clay slate, as well in this island as in Torsa, are found to be contorted; and, generally, in planes with a single curvature, the axis of which is parallel to the plane of the bed. As it did not appear that in these cases the beds themselves were bent, but that the flexure was limited to the laminæ, it is probable that this disposition is also a result of some modification of the concretionary structure. But it is a fact of too much importance in the general history of the schistose rocks, to be determined on evidence so imperfect and so limited. The contortions so frequent and remarkable in micaceous schist, will naturally occur to the reader's mind as admitting of a similar explanation. But in all [redacted] which I have examined in this latter rock, the

curvatures are infinitely more complex; while the beds appear also to be similarly affected throughout: besides which there occur certain minute circumstances connected with the contortion, apparently depending solely on mechanical disturbance. The decision of this question must depend in a great measure on our increasing knowledge of this rock, of which, common as it is, the geological history is but imperfectly understood. It is evident that the leading doubt in this case respects the structure of this substance; namely, whether the position of the mica is the result of crystallization or deposition, a question which I shall immediately have occasion to notice. I need scarcely add, that the contortions of gneiss are, to a certain extent, involved in the same decision; although in former parts of this work, undeniable instances have been adduced of contortions effected by the passage of granite veins.

The same trap veins which have already been described in Seil and in Torsa, occur in Luing, and in as great number and variety. They consist of basalt, common greenstone, claystone, trap porphyry, and compact felspar; and their positions, as in those islands, are sometimes parallel to the strata, at others transverse. To describe these particularly would be to repeat what has already been said, yet two of them are deserving of notice.

One of these occurs at the southern extremity of the island, and consists of a lax arenaceous claystone exactly similar to that rock as it is seen in Arran in overlying masses; a substance well known to geologists. As far as I could penetrate, its texture is uniform throughout; yet, from an analogous occurrence in Torsa, there appears reason to suspect that it is a weathered or partially decomposed rock.

The other vein is, to a certain degree, parallel to the beds in which it lies, and may be seen near the north-eastern angle of the island. It is composed of a brownish grey claystone, containing numerous dispersed scales of

copper coloured mica; being almost identical in composition with a rock formerly described in Kerrera. That which renders it peculiarly interesting, is the general parallelism of the mica; a circumstance which does not occur to the same degree in that rock, which, it will be remembered, is a rudely columnar and overlying mass. As this is an unstratified substance, and as there can be no question respecting its intrusion in the form of a vein, the mica must have been crystallized in the mass, and its parallel disposition is therefore the result of that polar tendency among distinct crystals which I have formerly noticed in speaking of the graphic granite in Coll. It will immediately be seen how this circumstance bears on the question of micaceous schist, as well as on that of gneiss; since in those cases the laminar disposition of the mica may equally be attributed to this crystalline polarity. I shall pursue the subject no further; it is one of the many obscurities remaining to add interest to pursuits which would soon lose all their attractions if there was nothing left for future inquiry.*

In concluding this account of Luing I have to add one remark, which applies not only to the schistose islands already enumerated, but to many of those about to follow. This is the absence of alluvial deposits or transported materials. There are no rivers capable of producing recent accumulations, and, as far as I have

* This being however an interesting question, as it relates to the rocks last named, it will not be amiss to add some other facts of an analogous nature which bear on it.

The pinite of Ben Gloe, described in the Geol. Trans. is generally found in prisms so short as to be mere scales. These invariably maintain a parallel position. The same circumstance is extremely common in the mica, which occurs, like this mineral, in veins of porphyry. In one of the varieties of the hypersthene rock of Sky, the crystals of that mineral are laminar, and placed in a position similarly parallel to each other, and, as in gneiss, to the plane of the bed in which they lie; though this rock is unquestionably an unstratified substance.

terr
isles.

traversed them, they present none of the larger transported stones supposed to be of diluvian origin, with the exception of Isla, where I shall have occasion to mention them hereafter.

It rests on the authority of Mr. Raspe, who was employed by the proprietors in the survey of some of the Western islands, that lead, zinc, and silver have been found in Luing. I could procure no positive information on this subject; and if I am inclined to doubt the accuracy of that report, it is not because my knowledge of the island is sufficient to authorize that scepticism. Circumstances dependent on the well known anxiety for the discovery of mines which pervaded the Highland proprietors some years ago, may perhaps account for this and similar reports.

TORSA.*

THIS small island occupies a point between Sc[illegible]ing, and the adjoining continent, whence it shares in the structure of the whole; connecting the interrupted parts of the eastern ridges which are common to these two islands, and extending the succession of the strata of Luing a step nearer to the mainland. The continuity of its strata to those of the two islands above named, together with their parallel disposition and community of structure, render it, in a geological sense, an integrant part of the group, and thus give it an interest which it could not claim in an independent view.

Torsa is about a mile broad and three long, and of an irregularly oval figure; consisting of one smooth and green hill scarcely 200 feet in height, with a lower subsidiary ridge to the westward, and descending to the shore, almost on all sides, with a gentle declivity. It is so intimately connected with Luing, that there is a passage from the one to the other till half tide, over a rocky bar not 100 yards in breadth; and it is beset with some rocky islets, which being merely detached fragments of the principal island, and partaking exactly of the natures of the different strata in the line of which they lie, require no particular notice. Through the intricate channels thus formed, the tide runs with great rapidity and in very complicated directions; the attention which is hence required to navigate them, adding much to the liveliness of the scene and to the interest excited by the picturesque intricacy of the whole strait, and by the clearness of the geological details which these

* Torst, dry, Danish. Whether this derivation be correct or not, the [illegible]n is very characteristic of the island. See the Map of the Slate

islands present. The direction and dip of the strata of Torsa, correspond exactly with those of Luing and Seil; and the prolongations of the beds in the two latter, point out, as they pass through Torsa, not only the boundaries, but the nature of the rocks of which it is composed.

The lowermost strata of the island form the western subsidiary elevation, and are so accurately prolonged upon the line of the grey ridge common to Seil and Luing, between which this part of Torsa lies, as to leave no doubt respecting their identity. This ridge is here also marked by the prismatic fracture, and by the same character of nakedness amid the surrounding verdure that covers the clay slate. Hence it is visible from a distance; while the conjectures thus formed respecting its structure, are confirmed at hand by the identity of the other accompanying strata with those already enumerated in Seil.

The island does not extend sufficiently to the westward of this ridge to admit of the clay slate appearing, as in Luing, on its western side; but the whole eastern part, with the exception of certain trap rocks and a small portion of graywacké, consists entirely of that substance. It has already been remarked, that the clay slate at the southern extremity of Luing, which, according to the order and position of the strata, is their eastern side, abounds in a substance approximating to drawing slate. The same circumstance occurs in Torsa; a great portion of its strata consisting of those black and soft varieties already mentioned. They often contain mica, irregularly and sparingly dispersed, and always disposed with the flat sides of the scales parallel to the laminæ of the schist. This soft schist, after long exposure to the weather, acquires in the interior a rusty brown aspect and becomes tender; the surface turning grey and pulverulent, like those rocks into which felspar enters as a constituent. I may here remark, that if the clay slate

occurring on the eastern side of the grey ridge in Luing and in Seil, is, from its limited quantity, held insufficient to prove there, a legitimate alternation between these two classes of rock, that circumstance is fully established by the extent of the former in Torsa; its horizontal breadth in the order of superposition to the grey ridge, being nearly a mile.

The stratum of graywacké above mentioned, lies on the east side near the shore, and is of so compact a nature that it is at first sight difficult to discriminate it from trap. In some cases, the specimens, even on minute examination, can scarcely be distinguished from some of the varieties of that family. This is an important fact, when it is recollected how often substances thus resembling basalt, are found stratified and interposed among the secondary strata, having apparently originated from the action of heat on the schistose clays; facts already stated at some length in other places, and existing in those, as they do here, in the vicinity of large masses of trap. In this instance the distinction is made by means of the quartz veins, which pass with an uninterrupted continuity from the clay slate through these interposed beds of graywacké; a circumstance that never takes place in trap rocks.

Together with these stratified rocks, Torsa presents many rocks of the trap family resembling those of Luing and Seil; but which, being in some respects even more remarkable, were reserved for a more minute detail in this place.

They are here also found passing through the strata at various angles; while in some places they put on the appearance of beds, being interposed among these strata in a parallel and conformable manner. In many cases, it is scarcely possible to distinguish them from real strata, either by defect of parallelism or by occasional deviations; yet, even then, they resemble the intersecting veins so perfectly in their peculiar aspect on weathering,

their superior permanence among the decomposed schists, and their prismatic structure, that they must be considered as parallel veins. But I need not dwell on this subject, as I could only recapitulate the arguments already used in support of this opinion on former occasions. Yet I may briefly remark, that here also, whenever they can be traced to a sufficient extent, they generally betray their true nature by some interference with the strata; either crossing at some point, or sending through them ramifying veins. It is also worthy of remark, that these parallel veins are more common here than in the northern isles where trap occurs. This appears to arise from the greater facility with which rocks of the schistose structure yield in the direction of their laminæ than in the opposite one; whence have originated the fissures afterwards filled by the trap. To confirm this view, a similar case will be described in Lunga; in which the nature of the rocks seems evidently to have determined the direction of the fissure and that of the subsequent vein.

The most remarkable of these parallel veins, both for number and magnitude, are to be found at the eastern side of the island. One of a great size, near the sea shore, projects to a considerable altitude above the surrounding strata, and is the seat of an ancient castle now in ruins.* This vein is not every where parallel to the strata, and seems to be a ramification from the great overlying mass of trap which covers the stratified rocks on the opposite shore of the mainland; the distance being but trifling, and many similar appearances being visible on that shore. The same occurrence has been already shown to be frequent, both in Kerrera

* Enough of this building remains to show the original design, which consisted of two united square towers with a circular flanking defence at one of the angles. The sides are so contrived as to be continuous with the nearly vertical walls of the vein.

and on the mainland near it; and it will be found to prevail throughout the whole of that district.

Veins of claystone porphyry, similar to those of Luing, are to be seen here, and apparently free from all those circumstances which might excite suspicion about their true nature, or lead us to imagine that they were decomposed rocks. They maintain the same character to the depth of many feet; distances to which our hammers cannot reach, but which have here been exposed by the operations of quarrying. That they are really weathered rocks, is however proved by the state of the great vein now described. In most places, even to the depth of some feet, it seems to consist of a claystone, occasionally becoming porphyritic, and not to be distinguished from those found in Arran, so familiar to almost every geologist in this country. But on cutting deeply into this rock, it is found that this is in reality a condition produced by exposure, as it gradually diminishes and entirely disappears at a certain depth; although it does not, during any part of the change, exhibit the well known characters of a weathered rock. The vein, where in its natural state, presents a greenish grey basis of compact felspar, interspersed with crystals of yellowish felspar, which, from the obscurity of their colour, are not very easily distinguished. In the first state of change it resembles a compact indurated claystone of a yellowish grey tint, the imbedded crystals becoming ochrey spots. It then gradually acquires a more lax and arenaceous texture, the ochrey spots being converted into cavities filled with a brown powder; beyond which no further tendency to change or decomposition can be perceived.

This circumstance is perhaps of more general interest than it appears at first sight, although I am not willing to mislead myself or others by indulging in too wide a field of speculation respecting it. In all the well known and ordinary cases of weathering, the mechanical decomposition of the rock follows soon after its decomposition;

so that we have seldom an opportunity of seeing rocks that have undergone this operation and are still in a state of integrity; the decomposed parts being commonly removed as soon as that process is completed. Yet in certain situations where granite or gneiss have been protected from mechanical violence by a covering of soil or peat, they are sometimes found decomposed to great depths; retaining nevertheless their natural structure and much of their ordinary aspect; but ready to fall to pieces on the application of any violence. I have mentioned an example of this in the gneiss of Sky, and it is also very conspicuous in Guernsey, in the same rock, as well as in the very small portion of granite which occurs in the Isle of Man. As a case more in point, it is also to be seen in the trap rocks in many parts of Sky, as was remarked when treating of that island. The weathering of the vein in Torsa is an analogous case; although the rock is not so far affected by the progress of the decomposition as to be susceptible of actual disintegration. It is not at present easy to explain the causes of these deep-seated changes in rocks, as it is not easy to conceive how air and water can find access to their interior parts; but it is possible that they may result from agencies of an internal nature independent of the action of the weather. Under such circumstances it is also possible that many rocks of the trap family, whether belonging to the traps strictly so called, or to the syenite, porphyry, and claystone divisions, may have been changed from the state in which they were originally formed, by corresponding causes. In such a case the changes would neither be limited in extent nor position; they would not be confined to the surface of one mass of rock, nor to the outer of many consecutive beds; but might perhaps occupy the whole of a single mass, or merely affect an inner one of which the composition admits such an alteration, when the outer, differently constituted, might escape. However speculative this view may be deemed, it is not

unworthy of further investigation; since, if established, it may tend to elucidate many circumstances in the alternations of softer strata with trap rocks of a hard structure, which have been considered at variance with the supposed igneous origin of these substances.

The last circumstance worth noticing in Torsa, is another peculiarity in the weathering of some of the trap veins, which, although it occurs also in Seil, was deferred, as the instances are here much more remarkable. Though here called trap veins, for want of a more definite term, and though generally known to mineralogists by the name of greenstone, they consist principally, often entirely, of compact felspar or of clinkstone; their colour, when there is any, being derived from iron, not from an admixture of hornblende.

In one of the instances selected for description, the rock, in its original and unaltered state, is white and compact. By degrees, as it approaches the surface, it becomes of a rusty brown, and at length that colour as gradually disappears, the external crust becoming white and pulverulent. In a second, the original rock is of a lead blue, and undergoes the same alterations. The changes which take place in the third and last instance that I shall here notice, are much more intricate and less easily explained. The vein in this case exhibits the following succession of colours; brown, buff, white, lead blue, brown; the first and last named, occupying the two external sides where it has been exposed to the weather.

The change from blue to brown which occurs in the second case is easily understood, since it results from the conversion of the protoxide of iron into rust. As the same rust is formed on the weathered part of the white rock described in the first example, it is evident that this rock also must contain iron, which is probably in the state of carbonate, and is afterwards converted into the brown substance by the absorption and combination

of water. In the third case, the interior of the vein presenting both blue and white tints, it follows that both the carbonate and protoxide are combined with the earthy basis; a circumstance which is proved by the change to brown taking place gradually at the outer side of each. If however we may trust to this natural analysis, the proportion of iron in the blue part of the rock exceeds that in the white; as the brown colour is far more intense on this side of the vein; a consequence that might easily have been foreseen from the appearances and nature of these different parts. The gradation occurring between the blue and white, would seem to indicate that the protoxide had in some way been converted into the carbonate; although it is possible that both these combinations of iron may exist in the rock independent of each other.

The last change which occurs in all these cases, is the disappearance of the brown colour, a pure white and powdery felspar forming the outermost superficies. The iron has here disappeared, and it is probable that this ultimate effect results from its supra-carbonation and consequent solution in the atmospheric water. This change is not uncommon in other rocks, and I have on different occasions remarked that it takes place in quartz rock, as well as in those combinations of quartz and felspar that occur in the sandstone series of Sky; which, although of a very dark colour, become bleached to absolute whiteness by exposure. As the change from white to brown is also not unusual, even in the most compact and whitest varieties of quartz rock, it is also probable that even these contain iron in the state above described; little as it would be suspected by merely examining their external characters.

SHUNA.*

This island, situated between Luing and the mainland, forms an important feature in the general history of the Schistose islands, in consequence of its lateral position with respect to the strata of Seil and Luing, and the extent and position of the series to which it belongs.

It is of a somewhat regular shape, being about three miles in length, and half a mile in breadth; and may be called flat when compared with the neighbouring objects, although rising into small hills of about 100 and 200 feet in height. Its surface is consequently uneven, and is every where diversified with rocks and natural woods of birch and alder, interspersed with patches of cultivated and pasture land. Like Seil and Luing, it is more picturesque from its situation and exterior connexions than from its form or internal arrangement; although far from deficient in that intricate mixture of land and rock which, when under the partial guidance of art, is productive of the milder classes of rural beauty.†

In the disposition of the strata, it partakes of that flexion in the line of bearing which has already been noticed in Luing; a difference of two points of the compass, or more, being perceived in that respect between

* See the Map of the Slate isles.

† The disposition of the natural woods in this island is such as to produce a very artificial appearance; nor is this feature unusual in the Highlands. The resemblance to the system of ornamental gardening adopted by the noted Brown, is often so striking as to mislead a stranger; the same belts and clumps occurring, but with somewhat more of the carelessness of Nature. If we did not know the meaner source whence his ideas of beauty in landscape were derived, we might almost imagine he had copied from this country. The origin of these clumps will here be found to consist in rocky ground inaccessible to cultivation, and that of the belts in the water courses.

the northern and southern extremities. At the latter extremity of the island the direction is north, inclining to the eastward; while at the opposite it is north-easterly inclining to the north; being parallel in both places to those of the strata in the islands with which it is associated. The point of flexure cannot however be ascertained, owing to the intricacy of the ground in the intermediate parts; or rather, it did not fall under my observation. It is not always possible to investigate these changes in a satisfactory manner, owing to geographical accidents well known to geologists. Yet however desirable it might be to trace these points of curvature, the defect will not interfere with the observations to be deduced from the fact; the purpose of these being, to bring into one general bearing the detached islands, which, like Garveloch on the one hand and Lunga on the other, affect different directions. Even under these aberrations, a great degree of consistency will be found in the disposition of the rocks throughout all the islands of this division.

The dip of the strata here, is, like that in the islands already described, towards the east; and the degree of inclination, though occasionally varying, lies within the limits already described; namely, between twenty and fifty degrees.

In composition, Shuna differs materially from the preceding islands, as it presents little or none of the clay slate so prevalent in Luing and Seil, as well as in Scarba and Lunga. The strata are also dissimilar in general appearance and alternation to those of all the islands to the westward; although essentially but repetitions of rocks which exist in some of these, and still more intimately connected with an important series that will be found in a position further to the south, occupying a considerable tract.

Micaceous schist and quartz rock are the predominating strata, constituting the far larger portion of the i

These alternate in frequent and thin strata, almost always very decided and without gradation, and are most easily examined on the southern and eastern shores.

The characters of the micaceous schist vary. At times it presents the most ordinary aspect, being a foliated mixture of mica and quartz. In other cases it is finely laminar and silky, consisting almost entirely of the former mineral.

The quartz rock is sometimes of a peculiar character; being of a buff colour, and, though extremely crystalline and compact, marked by a concretionary structure; while, from its great toughness, and the peculiarity of its fracture, it appears to contain felspar in intimate union with the quartz.

Among these predominant strata there occur several varieties or modifications of chlorite schist, some being of an unusual aspect; besides which, occasional beds of hornblende schist are also found alternating in an irregular manner with the other substances. It would not be easy at the present period of this investigation, to convey an adequate idea of the nature and connexions of this series; and as it occurs towards the south, under a much more interesting form, and through a much larger tract of country, it is preferable to defer the subject to a future period.

At each end of the island, a bed of dark blue crystalline limestone is seen among these strata; and it is wrought for economical purposes. The state of the intermediate ground does not admit of the continuity of these two rocks being traced; but from the general bearing of the strata it is possible that they are parts of the same bed. That does not however necessarily follow, as, in this schistose series, limestone is of frequent occurrence, and is generally found to occupy a very limited range; the beds, after a short progress, being extenuated to nothing.

It is perhaps almost superfluous to add to this cursory, sufficient, description, that trap veins occur in the

island; but, as far as I perceived, attended with no peculiarities that are not sufficiently described elsewhere.

Comparing the geographic position of Shuna with that of Seil and Luing, it is apparent that the strata which form it are superior in position to those of the latter, the common dip being to the eastward. If therefore our views were limited to these islands alone, we should conclude, that as the rocks of Shuna were placed above the clay slate of those two islands, they presented an anomaly of position sufficient to excite doubts respecting the accuracy of the observations. But it has been already shown that the same rocks are interposed between two masses of clay slate in the common line of direction which runs through Luing and Seil; and it will hereafter be proved that many similar alternations take place in the islands which remain to be described. But as these observations are of a general nature and apply to the whole group, I shall defer them to that period when a comparison of the whole of these scattered phenomena will be attempted.

GARVELOCH ISLES.*

THESE islands, disposed in a chain divided only by narrow sounds, are the westernmost of the group of which Seil, Luing, Scarba, and Lunga, form the most conspicuous parts. I have applied the name of the principal island to the whole, rejecting that of the Mare isles, which Mackenzie has erroneously given them; that name belonging, as I have already remarked, to Inish Capel. The name of the westernmost is Ilachanu, that of the central one Garveloch, and that of the easternmost Dunechow; names for which I am obliged to have recourse to Mackenzie, for want of other authority, although his orthography is often disputed by his countrymen.

They lie about five miles to the north-west of Scarba, the total length of the whole chain being somewhat more than three miles. Ilachanu, the westernmost, appears to be about a mile in length, Garveloch considerably more, while the easternmost is of comparatively insignificant dimensions; as is a nameless one which lies in the channel between the two former. The absolute resemblance of form and structure throughout the whole is such, and they are so connected by the rocks that lie in the straits which separate them, that they may be treated of as one ridge; the same general characters applying to the whole.

The general position of the ridge is N. E. by N., and it rises, although irregularly, from the south-eastern side to the summit; where it is abruptly cut off by perpendicular cliffs facing towards the north-west. Its greatest elevation appears to be about 700 feet. From this summit is obtained a most interesting view of the surrounding islands and more distant shores of the mainland. Among the former, the mountainous bulk of Scarba is most conspi-

* Garvelach, from Garbh, and cloch or clach; the rough rock. See [illegible] of the Slate isles.

cuous, prolonged gradually into the ridge of Jura, which vanishes at length in the distant haze where Colonsa is scarcely distinguishable in the horizon. In front, the dark cliffs of Inimore, backed by the mountains of Mull, extend their long line; while the intricate and glittering channels that separate the Slate isles from the Argyllshire coast, and the variety of rocks and islands scattered over the intermediate sea, contrast with these ruder features; the Linnhe Loch and the surrounding mountains of Cruachan, of Appin, and Glenco, stretching away at length beyond reach of the eye.

The surface of these islands is disposed in a very singular manner; consisting of deep narrow longitudinal vallies enclosed by high rocks, and presenting an aspect of seclusion such as we should only expect in the mountainous regions of an extensive district. The narrow limits of the little territory are forgotten, and the spectator, once entangled in these deep recesses, is no longer conscious that he occupies but a little point in the boisterous sea which is breaking round him. Nothing could be conceived better adapted for the solitude of a hermit; and accordingly, there are still existing remains on Ilachanu which bespeak its destination to religious objects. I can discover no account of these in the legendary or antiquarian histories of Scotland; they seem indeed scarcely known to any but the neighbouring fishermen, although they appear to have once enjoyed considerable celebrity, if we may judge from the number of tombs and crosses of which the remains are still existing. It is probable that, like the Shiant isles, St. Cormac's isle, and other establishments, this was a cell dependent on Iona; but that it attracted greater veneration than those, is rendered probable by the number of these apparently votive crosses, and by that of the warriors of former days, whose swords or atchievements are carved, each on the grey stone beneath which the once turbulent owner now sleeps in peace. Some walls, nearly ruined, bespeak the probable dwelling

recluses who inhabited the island. Here also is found the Clachan brath, which, like that of Iona, the fishermen or herdsmen appear in their occasional visits to preserve or renew; although every visitor thinks himself bound to contribute his efforts towards its destruction, and, with it, that of the "great globe itself," whose existence is to terminate at the same period. No patron saint now hovers over these remains; if ever indeed they had any other patron than St. Columba. Ilachanu is at present uninhabited, but there is a farm on Garveloch.

These islands are interesting to a mineralogist from the great variety of primary limestone which they present; to the geologist still more, both from the unexpected occurrence of this substance, and from the important resemblance which they bear to a very obscure part of the composition of Isla.

The incorrect position of these islands in the map of Scotland, is such as to interfere with the line of bearing of the strata, by which their form and position is actually determined. As this line is of importance in a geological view, not only as it affects the history of these, but as it relates to the whole of the Schistose islands, their position has here been reduced to that which is necessary to maintain the correct linear direction of the strata as indicated by the compass.

The tendency of the elevated edges of the strata is N. E. by N., as nearly as I could ascertain it, and there seems but little deviation from this position in any part; the whole chain being extended in a line corresponding to this. It will thus be seen that they conform in position to those of Seil and of the northern end of Luing. The dip of the strata is to the eastward, and consequently S. E. by E., and the angle of inclination to the horizon [illegible]es from forty to fifty degrees; exceeding or falling [illegible]m these extremes in particular places which are not

worthy of notice. As the same substances, in the same order of position, are found in all these islands, the same description will serve equally for the whole. The greater or less proportion between one species of stratum and another, which may be observed in the different individuals, depends solely on their several positions; or on that of their parts eastward or westward of a given line which may be considered as dividing the one set of strata from the other. Thus, in one, the limestone will be found to exceed; while in another it falls short in quantity when compared with the schistose rocks; or is even absent altogether.

*Commencing the examination of these rocks from the eastern side, as the uppermost in position, a series of beds is found, consisting principally of a schistose conglomerate; which will be seen hereafter to occur in Isla, and which I have also observed in Schihallien; interposed there, as it is here, among the strata of quartz rock, micaceous schist, and limestone, which constitute the chief part of that mountain. Its basis is a schist varying in aspect and character between a quartzose micaceous schist and an argillaceous one; or, if we were merely to consider the definition, resembling more nearly graywacké. Occasionally it passes into a pure quartz rock, and distinct beds of that substance, free from any of the foreign substances which characterize the prevailing beds, occur in alternation with it. Distinct beds of argillaceous schist are also found interstratified with this conglomerate schist; appearing to prevail chiefly at the lower parts where it first begins to pass into the accompanying limestone. The imbedded substances which produce the conglomerate structure, are, granular limestone of a yellowish and reddish white colour, red or white quartz, and granite. The fragments vary much in size, from that of a pea to a foot or more in diameter, and they are almost

* Plate XV. fig. 4.

all more or less rounded, as if from previous attrition. Where the schistose beds approach to the limestone, a gradual change of the character of the base takes place; clay slate containing distinct fragments of the same substance beginning to prevail, and alternating with distinct beds, or rather portions of beds, of the same rock in a simple state. The base then gradually becomes more calcareous, and is found to consist of minute fragments of slate and limestone; while the fragments of granite and quartz at length disappearing, those of limestone alone remain. Thus there is at last perfected a series of beds of considerable thickness, formed of a calcareous breccia having a compound base of schist and limestone, and containing imbedded fragments of the latter substance.

The analogy of this breccia, and indeed of the whole series, to those which occur in the secondary strata, is very apparent. Substituting sandstone, shale, and secondary limestone, for the three simple rocks above described, a sequence will be seen to exist among these primary strata, similar to that which occurs among the secondary. This is one, among many other examples, showing the great analogy between the primary and the secondary rocks: similar instances are pointed out in different parts of this work.

At length the breccia gradually disappears, and is succeeded by a continuous and compact limestone, of a granular texture and of great hardness. Its predominant colour is an ochrey or reddish white, occasionally mottled with grey and brown, and veined with dark red. These beds continue to the end, so as to terminate the whole series to the westward; forming the high cliffs already described. It is therefore impossible to conjecture what rocks follow in the order of succession downwards; as neither island nor rock intervenes between these and the southern coast of Mull, which has been already shown to consist of [illegible]ndary strata surmounted by trap. I shall here there[illegible]minate the account of these strata, referring, for

any conjectures which might be offered respecting those next in order, to the description of Isla, where the same series occurs; each place mutually throwing light on the other.

It only remains to mention the possible uses of this limestone as an ornamental substance.

The basis of the breccia is commonly of a slate blue colour verging to purple, and is mottled or sprinkled with the white or red spots derived from the calcareous matter; while the imbedded fragments being white, yellow, and pink, a very ornamental marble is the result. It is little if at all inferior to many of the Italian, or antique breccias of popular celebrity. The veined specimens of the simple limestone are, with a different character, equally ornamental; and, according to the direction in which the veins are cut, produce varieties resembling in disposition the well known marble of Sienna; but differing from it in colour, inasmuch as pink and dark red occupy the place of yellow and brown.

To these remarks I have only to add, that cubical pyrites occurs in the schistose rocks, and that I found a detached fragment of siliceous compact hematite; probably a nodule detached from the conglomerate.

As an appendage to this article it is proper to mention two islands which bear the same name and lie between these and Lunga; Garveloch na skian and Garveloch na more. They both resemble Lunga in composition, consisting of quartz rock; one of them being very conspicuous for a large erect vein of white quartz resembling, at a distance, the sail of a ship.

LUNGA.*

The principal islands which have just passed under review, consisting of Kerrera, Seil, Luing, Torsa, and Shuna, are so nearly associated in structure as well as in position, so that they have been considered as forming a subordinate group in the more general one that includes the whole of the Schistose isles. They have already also been distinguished by the title of the Slate isles, being the name by which many of them are popularly known in the country.

The four next to be described, namely, Lunga, Scarba, Jura, and Isla, are equally associated by a common geological bond of union; the predominant features of which are, the prevalence of a continued line of quartz rock, and the frequent alternations of this substance with micaceous schist, clay slate, and graywacké. In a geographical view they are equally connected; forming a chain of considerable length, although its constituent parts are of very unequal dimensions: they have therefore been combined into another subordinate group. The analogy between them will be found to extend to the disposition of their strata and the forms of their shores; but as these several points of relation will be best understood after they have been described, I shall defer the general comparison till then, commencing here with Lunga and proceeding southwards to Isla.

So intimate is the geographical connexion between Lunga and Scarba, and such the continuity of structure, that a perfect description of the one would, in a geological view, leave little to add respecting the other. It will indeed hereafter be seen, that the same structure is protracted, with scarcely any change, to the northern part of

* See the Map of the Slate isles and also the General Map.

Jura; and beyond it, with changes of little moment, through the southern division of that island, as well as through that portion of Isla which is a continuation of the line assumed by the prolonged edges of the elevated strata that compose them both.

Lunga consists of a long, irregular, hilly ridge, scarcely rising to the height of 1000 feet where it is highest, and generally not attaining half that elevation. It possesses no level ground, but is disposed in uneven, rocky, and often naked eminences, interspersed with patches of boggy ground and heath, as well as with occasional coppices of birch and alder; the natives of these coasts, wherever shelter is to be found from the sweeping westerly winds. There is scarcely any arable land, even under the system already described, where every patch capable of being turned for a few continuous yards by the plough or the spade, is brought into a state of cultivation. The western side is almost entirely rocky, bare, and abrupt; on the eastern, it descends somewhat more gently, skirted by shelving rocks, but displaying a greater extent of verdure, such as is the verdure of these stony and dripping mountains. The length of this island is about two miles and a half, and its breadth scarcely one, where widest; under which dimensions are included some detached portions that are insulated at high water by a tide flowing through several rocky channels with the rapidity of a torrent.

Lunga is separated from Scarba by a very narrow strait, divided at the eastern extremity by a rocky islet; the tide rushing through both passages, and generally through the whole sound, with a turbulence and impetuosity as great as that of the far more celebrated Corryvreehan. It is only by navigating this strait, and by coasting these wild and weather-beaten shores, that an adequate idea can be obtained of the structure of the island; and, for this undertaking, a nice attention to the state of the tides is required; without which, the passage,

nearly impracticable even in calm weather, becomes, with an adverse tide, or in windy weather, extremely perilous. In all cases it is advisable to pass the strait with the ebb rather than with the flood, or to enter from the west, if it is not convenient to do so at slack water. The superior turbulence of the tide of flood, both in this strait and in the Coryvrechan, arises from its course being directed westward; thus opposing the prevailing winds, as well as the western swell, which is seldom absolutely insensible. These directions will form an useful addition to the itinerary of a geologist; who will seldom fir boatmen either willing to make the attempt, or acquaint with the means of effecting it; and who, without muc local knowledge of the navigation of the Western islands, will find himself impeded at every step of his progress and disappointed in half of his pursuits. The perfect display of the rocks of Scarba, as well as of Lunga, which he will thus witness, will amply repay him for the risk or anxiety he may experience in this undertaking; and the admirer of picturesque beauty will be no less gratified by the magnificent dreariness of the scenery which he will find. Even from the different eminences of the island the views are extremely grand; whether the glassy surface of the sound of Luing is quietly meandering like a mighty river in circling eddies, or the wind and tide in contention, whiten it with a sea of little less turbulence than that of the Coryvrechan itself. It is from this island that the majestic features of Scarba are best contemplated, rising in one dark yet varied mass from its rocky shores and woody amphitheatre; and finely contrasted with the long low lines of the opposite coasts, and with the numberless rocks and islands that diversify and adorn this intricate sea.

In a geological view, Lunga consists of two principal members; argillaceous schist occupying the eastern side, and quartz rock the western: each of these being in-

termingled with other schistose substances which will also be found to alternate with them throughout the whole southern course of the same strata in the remainder of this chain. The general direction of these strata in Lunga, corresponds with that of its eastern shore; the bearing of which however, as laid down in the large map of Scotland, is not coincident with that direction. It is north, or somewhat more easterly, subject to that slight occasional flexion which prevents it from being determined accurately by observations taken at any single place. It will be found to correspond very accurately with the bearings of the strata in Scarba, and in the northern extremity of Jura; but deviates by two points, or somewhat less, from those of the southern portion of this latter island, as well as from their apparent prolongation through the eastern division of Isla. It differs by the same quantity from the bearing of the strata of the neighbouring islands on both sides; namely, from Seil and the northern part of Luing on the east, and from the Garveloch islands on the west. With the southern division of Luing, the correspondence is more exact. The dip is the same as in those islands, eastward; and it will hereafter be seen that this is the predominant one throughout the whole chain to the southward. The quantity of the inclination corresponds also with that of the strata in the islands already described; vacillating between 20° and 60°, but so that 40° may perhaps be taken as the predominant one, both in this island and Scarba, as well as in the northernmost parts of Jura; among all which it is scarcely possible to discover any geological distinction.

The argillaceous schist forms an irregular ridge on the eastern shore; occupying a very narrow space when compared with the quartz rock, which extends over the highest parts and by far the largest portion of the island. Its dimensions are irregular, because the indentations of the shore undulate on each side of the

leading line of the strata, and because its common boundary with the quartz rock is not parallel to that line. Although this rock is here predominant, it does not maintain exclusive possession, since it alternates with micaceous schist. Both these substances present very decided characters; the latter being brilliant and composed of grey mica interlaminated with quartz; the argillaceous schist differing in no respect from that of the Slate isles, and being capable of affording slates similar to those of Eysdill.

Although the belt of argillaceous schist is thus described as if it were separated from the quartz rock, there is no defined boundary between them; various alternations taking place before the latter is established to the exclusion of the former. It cannot indeed be said to be ever thoroughly excluded; since beds of the simplest argillaceous schist are found alternating with quartz rock of a perfect character, even to the western side of the island, and nearly down to the bottom of the lowest accessible strata. Nor, on comparing the structure of Lunga with that of the remainder of this chain of islands, can any point be fixed on in the quartz rock, however thick its mass, below which beds of that schist are not found.

The beds of quartz rock which, under this exception, occupy the western side of Lunga, exhibit elevations corresponding to those of the schist. As the passage of the sound formerly described, affords an opportunity of seeing their transverse sections in great perfection, the incurvations which cause their elevated planes to assume so many different angles when examined on the lines of bearing, are brought fully into view; affording a very instructive explanation of the circumstances which, in other situations, produce the varying inclination of similar strata. The beds of quartz rock differ in thickness from one foot to forty or more; and the causes of separation among them will generally be found to consist in the

intervention of some substance differing from the predominant one, or to arise from some change of structure in the consecutive strata.

The simplest substance among these beds is an extremely compact and crystalline granular quartz, varying from white or pale grey to a darker blueish grey, and scarcely yielding to the impressions of the atmosphere; although the coloured varieties become bleached to perfect whiteness at the surface and to a small depth within it; in consequence of some chemical change of the colouring principle which was lately noticed in treating of the Slate isles. The change to whiteness takes place here, as in the trap veins of those islands, through the intervention of a brown lamina; the protoxide, or carbonate of iron, being converted into rust before the colour is finally discharged. It is difficult to understand how water can procure access beyond the immediate surface of a substance so compact as this rock.

The grains of quartz occasionally become larger, and a coarse compound is thus formed; while, in other cases, coarse gravel and fine sand are irregularly mixed in the same bed; the whole being condensed into a semi-crystalline mass of extreme hardness.

These simpler rocks, whether fine or coarse, alternate in frequent changes with other beds, which consist of the same substances as bases, intermixed with fragments, both of micaceous schist and of clay slate that vary much in size, and sometimes attain even the length of an inch. In these instances, the compounds resemble the well known sandstones which occur among the secondary strata and contain fragments of schist; and which differ from these, chiefly in the absence of the crystalline texture, and in the inferior hardness of the base. As these compounds become finer, a series of rocks is gradually produced, terminating in an aggregate of quartz grains cemented by schist, and not to be distinguished from

graywacké; alternating every where irregularly with all the other rocks before described.

As these beds occur, even in greater variety, in the remaining islands of this group, and will again necessarily come under review, it is here unnecessary to enter into any further details respecting them.

Numerous trap veins are seen traversing the strata of this island. They have no certain direction, being in some places erect, in others inclined; at one time intersecting the beds in angular directions, at another insinuating themselves in a parallel course between their laminæ. In some cases, the same vein will be found to occupy both positions, changing its course from a transverse to a parallel one. The deep and perfect sections of the rocks, both here and in Scarba, enable us to trace distinctly those arrangements in the veins, which, in most instances, where the surfaces only admit of examination, are nearly as much matter of induction as of observation. It is from those veins which are entirely or in part conformable to the planes of the strata, that we are enabled to understand the manner in which the character of the including rock has affected the form and disposition of the vein. Where its course lies at angles with the direction of the strata, it is generally straight and persistent, while its breadth is equal throughout; as if the violence and suddenness with which the original fissure was formed, had been such as to disregard all impediments arising from inequalities of hardness; these bearing no proportion to the force exerted in the separation. Where, on the contrary, the fissure has taken place in the direction of the beds, the vein will often be found unequal in thickness, and sometimes curved, or even tortuous; from the greater facility with which these have yielded in that direction, and from the inequalities originally existing in the disposition of the laminæ which by their sepa-

ration have given a passage to the fluid intruding material.* Such appearances are here both frequent and remarkable; and analogous, if not equally well marked facts, occur in other parts of the Western islands. There is nothing in the mineral character of these veins to call for particular notice; but I must not omit to mention, that in one instance, a wide vein is found to include in its centre fragments of quartz rock and schist, similar to the surrounding rocks, but broken and twisted in several intricate directions; an appearance resembling that which occurs in the granite veins of Mull.†

Having thus described the structure of this island, it only remains to examine its relations to those which have preceded it in description. It has been shown that the western side of Luing consists of clay slate, and that the same rock occurs on the east side of Lunga, differing from the former in no respect, either in character or position; the chief distinction lying in the greater frequency of micaceous schist, which is however not entirely absent in Luing. This alternation becomes more frequent, and the micaceous schist more predominant, as we approach to the quartz rock; an observation that will be confirmed by the examination of Scarba. The eastern side of this island projects far beyond the line of direction which is the common boundary of the clay slate and quartz rock; and thus, admitting of a much more continuous and extensive succession of the former rock, enables us to trace the diminished frequency of the beds of micaceous schist at a distance from the latter.

From the final disappearance of the quartz rock at the eastern boundary of both these islands, and from its absence on the opposite shore of Luing, it is a natural conclusion that those parts of the surface

* Plate XXI. fig. 2. † Plate XI. fig. 6.

which lie here buried from view beneath the sea, are also composed of clay slate. This opinion is confirmed by the nature of the intermediate islets and rocks; which were examined for that purpose. If, either meridian lines, or lines on the N. E. by N. rhumb, under which the directions of the strata are all included, be drawn through the several rocks and islands in this sound, it will be seen that the mutual distances of these, on the parallels, scarcely amount to a quarter of a mile in the former case, while in the latter they are nearly coincident. It will also be found that Eilan na gaun, situated near the northern end of the largest division of Lunga, consists entirely of clay slate; and that the same rock constitutes Balnahua, Blada, an unnamed island to the south of these, and the Isles na kiran which occupy the western shore of Luing. The ridgy forms of the sunk rocks in the intermediate channels, are equally indicative of a corresponding composition, and give as complete an insight into the structure of the submarine land as can be expected under similar circumstances; while they are sufficient to prove a regular sequence from east to west, of the rocks which occur on each side of the chasm formed by the strait of Luing.

SCARBA.*

This island is the second in the chain of which Jura and Isla form the southernmost parts and Lunga the northern; being, as I have already remarked, continuous with them in structure and in geographical position. The structure of Jura indeed, would in many points be difficult to discover, were it not for the illustration which it receives from the more exposed and perfect arrangements visible in Scarba and Lunga.

The details of the rocks of Scarba are seen to the greatest advantage in the deep natural section which separates it from Jura, and is the northern boundary of the strait so well known by the name of Coryvrechan; the Charybdis of Scotland, that realizes the dangers with which poetry seems in former times to have invested the Sicilian gulf. This section may be examined from the land, but the journey is toilsome and rugged, nor is the whole so obvious as from sea. The geologist will therefore be pleased to know that even the terrible Coryvrechan has its periods of repose; when he may, with due caution, make use of his boat in viewing this instructive and magnificent shore. The natural grandeur of the objects is not a little increased by the circumstances of terror with which the very name is attended, and by the certainty of the impending danger; the periodical and inevitable return of which, threatens at every instant, him who may have miscalculated his time, or who may linger away his minutes on rocks more dangerous than those of the Syrens.

The circumstances that constitute the dangers of this sound, are, in a less degree, to be seen in many places

* Scarpa, sharp, Danish. Terms derived from this root are still parts of the English language. See the Map of the Slate isles.

throughout the narrow passage so much frequented by ships, which lies between Jura and Scarba, and the mainland. They arise from the constraint which the tide-wave undergoes in a narrow and rocky channel, and are displayed in a succession of currents and eddies that render the steerage of a vessel exceedingly difficult in calms, and produce, in gales of wind, a short and dangerous breaking sea. The flood tide runs through the gulf of Scarba from the eastward, being a branch of the great stream which is here directed to the north; and as it is much obstructed in the passage of the Coryvrechan, its rapidity is very considerable. This has been computed at twelve miles or more in an hour; an estimate which is evidently extravagant, and perhaps nearly double the actual velocity. The ebb has of course the reverse direction; but the stream is less swift, and the agitation of the water is consequently much less violent and dangerous. This agitation is chiefly produced by a rock of a pyramidal form, rising with a steep aclivity from the bottom, which is here about 600 feet deep, to within about ninety feet of the surface, and diverting the course of the rapid tide already described. The stream being thus obstructed, assumes numerous intricate directions, which, interfering with each other, cause the water to break with considerable violence. If there be a fresh breeze, and more particularly if the motion of the wind is opposed to that of the sea, this agitation is increased to a frightful degree; frightful at least to a seaman who knows its dangers, although, to a landsman, it may seem less terrible than the long surging roll of the Atlantic wave. It is this breaking sea which constitutes the real danger of the Coryvrechan, as, when considerable, it will in an instant sink a vessel, unless every thing is made secure on deck. The impulse of the stream against the rock above described, produces also a long and rapid counter-current or eddy on the side of Scarba; which, returning into the principal

stream in an opposite course, causes the chief gyration, or the whirlpool; the danger of which is comparatively trifling, since the only effect of it is to prevent the steering of a vessel: the real danger is in the breaking of the sea. Independently of the principal whirlpool, there are numerous others in this stream, as in all similar situations; which, however dangerous to a boat, are of little consequence to a vessel, particularly if there be wind. All this motion and turbulence vanish at the change of tide; so that even small boats navigate this sound with safety by watching the termination of ebb or flood; there being an hour or more of repose in neap, and half that quantity in spring tides.

The length of Scarba is about three miles, and the breadth, two. It consists of a mountain of an oblong conoidal form rising suddenly from the sea; but more steep towards the west and south than on the opposite sides, and skirted by a lower subsidiary ridge to the eastward. The height of the mountain appears to be about 1500 feet, and the shores are generally high and rocky, or precipitous; except on the eastern side, where a shallow bay is formed by a slight receding of the coast. With the exception of the ridge above mentioned, the surface is rocky and clothed with heath; but the eastern shore is verdant and covered with natural woods, forming one of the most beautiful objects in this sea. Besides the noble sweep of this magnificent amphitheatre of rock and wood, it commands the variegated and intricate channel of the Slate isles, with the sound of Oban and the distant ranges of mountains that extend from Cruachan to Ben Nevis. Few pictures of superior beauty are to be met with throughout the whole of this various and interesting coast.

THE geological structure of Scarba will be much illustrated by a diagram* representing in a general way

* Plate XXIII. fig. 1.

that section of it which may be seen from Coryvrechan; which also serves, as will hereafter be found, the additional purpose of explaining the structure both of Jura and Isla. The reader is however already prepared to understand it from the description of Lunga which has preceded.

The principal body of the mountain is formed of quartz rock, disposed in beds with the same northerly direction as those of Lunga, and like those also, dipping towards the east in angles of forty or fifty degrees. The edges of these beds, as they succeed each other in steps, and their flat surfaces, may be traced every where throughout the island, and they are always very distinct where the natural sections are exposed. In this respect, as well as in the absolute identity of the rocks of which it is formed, Scarba is perfectly similar to Lunga; and it is equally apparent that these two islands are portions of one continuous ridge of primary strata. As I have already described some of the most remarkable characters of the predominant substance, quartz rock, and shall have occasion, when treating of Jura, to enter again more particularly into the details both of its mineral characters and geological relations, it is unnecessary to dwell on them here. Many varieties occur throughout this extent. There is here also, as in Lunga, to be seen in distinct sequence with the ordinary strata, that rock which although existing in Jura, is there, from the nature of its geographical position, incapable of being examined to the extent requisite for determining its relations to these. This is the fine conglomerate; composed of quartz, clay slate, and micaceous schist, cemented by a paste of the two latter substances; beds of it being found alternating with the common quartz rock. It is precisely similar to some of the most frequent varieties of graywacké; but the considerations arising out of this fact must be deferred until the whole series can be examined in one collective view.

The quartz rock of Scarba, like that of Lunga, is found

both to alternate with, and pass into, micaceous schist; and thus a rock is often formed, partaking in such a manner of both these, that it may with equal propriety be ranked with either. As the geological relations of these two substances are the same, it is not necessary to distinguish them in describing their alternations with the clay slate. These may be seen all along the eastern side of the island; the several beds succeeding each other without any determined order, and the clay slate, as might be expected from the preceding remarks, sometimes alternating with the quartz rock, at others with the micaceous schist. If there is in either case a gradation at the line of junction, it is very slight. It is evident that this clay slate is the same rock that constitutes the Slate islands, formerly described; since, as I have already shown, it forms a part of the same series of beds, however geographically interrupted. It is perfectly soft and fine grained, of a dark blue colour, silky and undulated on the surface, and contains cubical crystals of pyrites. As its alternation with the first named set of rocks, is to be seen on the eastern side of the island, so the regular interchange of the two is visible in the transverse section of the whole on the southern shore. The undulation of the mass of strata which here occurs, is very remarkable, and it is represented in a general way in the accompanying section.* It is impossible that any error can have intruded itself into these observations, since the whole is as palpable as if it were presented in a model.

Trap veins of considerable magnitude are found here, and they are probably the causes of those disturbances visible in the rocks, which are independent of the general undulation. These disturbances consist in a confused intermixture of the quartz rock with the clay slate; the evenness and order of both being interrupted, and fragments of the one being irregularly interspersed among the other.

* Plate XXIII. fig. 1.

The accompanying figure will illustrate this appearance better than any description.* In these instances the contortions put on various appearances; sometimes extremely intricate, but not very difficult of explanation. In the greater number, the slate appears to be bent and elongated, while the accompanying quartz rock is broken: there is consequently a want of correspondence between the two substances where the contortions take place; although in their immediate continuations, where undisturbed, they preserve an uniform parallel alternation. It is probable that at the time when these changes were effected, the quartz rock was perfectly indurated; while the slate was in that state of softness resembling moist clay, which it appears in many cases to have retained long after the period of its deposition. This opinion is confirmed by considering the different nature of these two rocks. Whether the former is a mere aggregate of particles previously crystallized, or a compound of such particles united by a crystallized cement of quartz, it could scarcely have existed in a very flexible state. Accordingly, it rarely presents instances of flexure, and even these, where they occur, are trifling when compared with those which are so frequent in the other primary strata. Many of these latter substances have unquestionably been deposited from water, either in the state of very fine powder, or of extremely minute fragments; while in some instances, and particularly in the case of limestone, a process of crystallization has either taken place in the deposited mass, or has proceeded simultaneously with the precipitation of the earthy matters. The quantity of water which substances in this state are known to hold, and which in the case of deposits of clay in particular, is so remarkable, will explain their power of retaining a certain degree of flexibility, or, in some instances, even an absolute ductility, long after they have assumed the external

* Plate XI. fig. 4.

form of a rock. The supposition is indeed sufficiently confirmed by numerous facts in the history of rocks, proving their softness and flexibility even at this day, when first taken from their beds; examples of which have been noticed in this work on different occasions.

These considerations will account for the peculiarities visible in the contortions of Scarba; and the spectator who examines them will readily acquiesce in the explanation, although no adequate idea can be conveyed of the value of these proofs; since even drawings are incapable of representing them in a satisfactory manner.

The facts are themselves interesting in a general view, as bearing materially on a subject which has been the occasion of some controversy, and is of no small importance in geological theory. Many geologists have been unwilling to admit of the mechanical derangement of rocks, and have consequently had recourse to other modes of accounting for such appearances. Saussure seems to have been the first to suppose that contortions might have resulted from crystallization, and the respect due to his name renders it proper to notice an opinion which seems unsupported by any chemical analogies with which we are acquainted.

Those which occur here, present circumstances irreconcileable to the notion of a chemical arrangement, while they display ample proofs of mechanical disturbance. Where the mass of beds, consisting of quartz rock and schist, is erected from its once horizontal position, or is disposed in the extensive undulations visible in the diagram, the regular alternation of the two substances continues; the whole having equally undergone the degree of flexure exhibited in its present disposition. The actual curvature at any one point is in this case so small, that even the presumed rigidity of the quartz rock has been capable of yielding to it. But the present argument would not be affected should we even admit that this general mass had been deposited in its present position;

since, in the more minute and sudden contortions, although the schist has yielded so as to conform itself to the new position into which it was forced, the quartz rock has been fractured; and instead of presenting contortions and flexures parallel with those of the schist, is irregularly intermixed with it, or deviates from the parallel and alternate position which it maintained in the former case. Had such contortions been the effect of crystallization, it is probable that the compound mass would have obeyed the same laws in the less as in the greater instances; and that, in both cases, there would have appeared the same flexure, elongation, and parallel adaptation of parts in the quartz rock, and in the schist.

This summary of the geological constitution of Scarba includes the principal appearances; and, in omitting minor details, I have been influenced by the recollection that similar facts are described either in one or another of the associated islands.

But I must not terminate this account without offering some remarks on the alternations of these schistose rocks; since their order in these islands contradicts some prevalent opinions, and leads to important results both in geological investigations and in the formation of a general theory. It will be proved in treating of Jura, that quartz rock alternates with and graduates into micaceous schist, and that they are consequently as much members of one deposit, as common sandstone and shale. Their geological place is therefore the same. It is generally said that clay slate is the next rock in order to these, and that it follows micaceous schist as it is itself followed by graywacké. But I have on various occasions shown that graywacké and clay slate alternate. There is consequently, in these two rocks, an equivocal relative position to the surrounding strata, similar to that of micaceous schist and quartz rock, while each pair presents a certain analogy of composition to the other. As the finer and more easily suspended substances which constitute mica-

ceous schist, may be supposed to have separated from those that form the principal parts of quartz rock, which have in water a greater tendency to gravitate; so the finer clay from which clay slate is formed, has probably been separated from the coarser fragments and particles that constitute the numerous varieties of graywacké. Both receive illustration from the association of conglomerates with finer sandstones in the case of the secondary strata; the analogy in general being considerable, and the principal differences appearing to consist in changes, produced through long continued periods of repose, or under circumstances with which we are unacquainted. Since also the alternation of conglomerates and sandstones is irregular, and that each of these occupies by turns the highest and the lowest relative position, there is no reason to be surprised at the alternations of quartz rock and micaceous schist, or of clay slate and graywacké.

It must now be remarked, that in the case of the older stratified rocks, the alternations are even more general, since all the four substances just enumerated are in these islands found to alternate without any regular order; the graywacké and clay slate being irregularly intermixed with the other two rocks, and it being impossible to assign the position of inferiority to any one of the whole set. The evidence for this uncertainty of position, in Scarba, in Isla, and in Jura, is so perfect, and so obviously free from the possibility of mistake, that it cannot be evaded by any supposition. An unbiassed observer would not indeed consider it as a matter either of doubt or discussion, nor is there *a priori* any ground for doubt, since it does not present any improbability. Where clay, mica, and quartz sand have been gradually deposited, produced as they must apparently have been from the waste of more ancient rocks, and where the particles of these different substances have been reduced to different degrees of fineness, it is rather more surprising that the alternations and mixtures are not more frequent, than

that they should occur in these islands.* It may for ever remain impossible to explain the causes by which even their present distinctness has been produced, and their boundaries determined. It can only be conjectured, that the differences in the constitution of the rocks from the ruins of which they have been formed, those of the cavities in which they have been deposited, or of the tides and currents to which they have been subjected during their deposition, have, under various modes of combination, produced all the variety of appearances now visible. I need scarcely point out, that in this case also, the alternations of fine and of coarse argillaceous schist (slate clay) with the secondary sandstones, present a striking resemblance to those of the primary strata under review. From these and other instances occurring in the course of this work, it may safely be concluded, that the present theory of a certain fixed order of succession in the primary rocks is still imperfect; since every day produces fresh reason to doubt our knowledge of its nature and limits.

In dismissing this subject it is necessary to make some remarks on the term graywacké, since it has here been used in a sense more extended than that which is generally received. It has been enumerated only among the rocks called *transition*, while it has here a place among the primary. There can be no dispute respecting the definition, which is abundantly clear; nor can any essential difference be found among the several varieties of it which occur in the situations now described, and those found on the confines of the secondary strata, to which the term *transition* has been applied. Particular speci-

* That observation may be more generally extended to all the mixed rocks. Among the infinite possibilities of mixture, they are limited to a very few; and their characters, under modifications which do not affect this general conclusion, are surprisingly constant. It is not the least remarkable part of this law, that the same mixtures are found without material variations of character over the whole globe.

mens may differ, and even entire beds of graywacké, occurring in the immediate vicinity of secondary rocks, may be remarkable for the same laxity of texture by which these are characterized; while the same substance involved among the primary, may present an unusual degree of comparative hardness and compactness. But the general character remains unaltered, and the correspondence of the specimens with the definition continues perfect. If geologists are desirous of distinguishing them by their position as well as their mineral character, a practice often convenient, and even necessary, they may receive appropriate names; or those who are still inclined to retain the terms of *primitive* and *transition* may have recourse to them as adjective terms. The term quartziferous clay slate has indeed been applied to these rocks, but there are other substances possessing a distinct character which have a stronger claim to this appellation.

JURA.*

JURA is among the largest of the Western islands, and is conspicuous at a distance, from the considerable elevation no less than from the peculiar forms of its mountains. Its greatest length, extending from S. W. to N. E. is about twenty miles, and its breadth at the southern end, eight; as far as any reliance can be placed on this very doubtful department of Scottish geography.† From this widest part, the breadth diminishes gradually northwards, till it is reduced to two miles. The aspect of the island is rugged and mountainous, and it may, in a general sense, be considered as a continued mountain ridge; since it can scarcely be said to possess a valley, or to terminate in any other plain than that of the surrounding ocean. The shores therefore, as might be expected, partake of this general character, being commonly rocky and often abrupt; seldom descending to the sea in gentle slopes or flat meadows. Under these circumstances, Jura is almost void of picturesque beauty; if we except the cliffs, the caverns, and the arches which are to be seen on several parts of the coast.

The highest part of this island lies toward the south, where it rises into four distinct hills, of which the three principal are well known by the name of the Paps, being seen far at sea and from all the western coast of Argyllshire. There is not much difference in the heights of these three elevations; and that of Ben an Oir, is about 2500 feet. They have all an irregularly conoidal form, sometimes displaying considerable portions of the naked rock; but being more frequently enveloped with heaps of large fragments which conceal it and

* Correctly, Diura; from Diur, a deer. Swedish.—See the Map.

† There is no section of Jura given, as it would have been nearly identical with the eastern portion of Isla, to which the reader may turn. Plate XXII. fig. 4.

give a smooth outline to the declivities. An extensive view of the northern islands, and of the coast of the mainland, is to be obtained from these summits, of which Ben an Oir is by much the most easy of access. To the geologist, this landscape, various and splendid as it is, will be less interesting than the perfect display hence visible, of the structure and disposition of the rocks which form the island itself. The continuity of the strata, and the irregularities in the outline of the general ridge, can be distinctly seen from one or other of these summits, and best from the most northern; whence it is easy to trace that continuity for a considerable space northward, even across the Coryvrechan to Scarba.

The soil of Jura partakes of the barrenness of the rock on which it lies; being sandy, and, from the wetness of the climate and want of ready drainage, much encumbered with peat. It contains but little land really arable, and is chiefly employed in the rearing of black cattle.

Some insignificant lakes are found in the vicinity of the high mountains; and one or two streams, scarcely to be dignified with the name of rivers, flow into the sound which separates it from Isla; descending from the Paps and, being, from the general moisture of the climate, permanent. There appear to be no alluvia or extraneous rocks worthy of regard: the geological interest of the island is comprised in the very admirable exposition which it affords of that important member of the primary strata, quartz rock; which forms the basis, and indeed the principal part of its structure.

INDEPENDENTLY of its geology there are some circumstances connected with the natural history of Jura which are deserving of notice.

It has been said to abound in vipers, like Lamlash and other islands; in corroboration of which Mr.

Pennant's authority is generally quoted; although on referring to that naturalist, it may be seen that he only gives it as a current report. This animal is, on the contrary, rare, as it is elsewhere throughout the islands; and on conversing with the natives, though every one quoted the general belief, no one was ready with the instance. This indeed is one of the popular beliefs which, like that in witchcraft, continues to be circulated, and for nearly the same reasons, long after it has been disproved. Since Mr. Pennant's name must necessarily give weight to any statements connected with natural history, it is proper also to notice in this place a tale which he relates as it was related to him, respecting another animal the existence of which is visionary, but in which he, as well as Dr. Walker, appears to have believed.

This is the fillan, a worm which is said, like the Guinea worm, to insinuate itself under the skin, so as to cause tumors and abscesses. The belief in this animal is not limited to Jura; it exists in other parts of the Highlands. On investigation, this pretended origin of those diseases will be found purely imaginary, and, like many other of the supposed causes of Highland ailments, to be founded on traditionary tales. Supernatural or extraordinary causes of disease are, in the infant state of society, not limited to witchcraft alone. These notions are however fast hastening to oblivion, and, with them, superstitious and fantastical methods of cure are also disappearing. The increase of rational knowledge, and of a portion of common-place philosophy, which, however insensibly, is still slowly and regularly diffusing itself throughout the people, will shortly dismiss the fillan, together with many similar creeds, to the general repository of forgotten systems.*

Of the few equally imaginary specimens of natural

* There is a considerable resemblance between this belief and that in the Furia infernalis; the effects of which, even if its existence be admitted, must be greatly exaggerated.

history still found in the Highlands, the water bull seems as yet to maintain his ground with some obstinacy; and, like other goblins, is not in want of positive ocular testimony in proof of his existence. This animal is supposed to reside in several of the lakes, in Loch Awe for example, and in Loch Rannoch; combining powers and properties worthy of the pen of Spencer. He is occasionally angled for with a sheep made fast to a cable secured round an oak, but as yet no tackle has been found sufficiently strong to hold him.* But enough of these, since Jura presents specimens of undoubted reality, more worthy of investigation.

When becalmed some years ago on the eastern shore of the island, I had the fortune to take a fish not yet known to naturalists, and which it will not therefore be out of place to describe. It is of the genus Petromyzon, and forms a new species in this family, hitherto but imperfectly known.† It was found adhering to the back of a grey gurnard which, as well as the striped gurnard, not included in Mr. Pennant's catalogue, abounds in these seas. As a naturalist, I must censure the humanity of the sailor who threw it back into the sea after the drawing and description were completed.

All the species of Petromyzon as yet described by ichthyologists are inhabitants of fresh water; with the exception of the marinus, which migrates into rivers for the same purposes as the salmon. The present

* This belief is not so completely limited to the most credulous part of society as the reader might imagine. In one of these Highland excursions I met a farmer who was watching for one of those monsters, while his two sons were disturbing with dung forks the deep holes where he was supposed to be lying. The musket was loaded with sixpences, as it is reputed that he is vulnerable by silver shot only.

† Plate XXIX. fig. 1.

differs from that species, not only in size but in other important circumstances; while its residence alone proves it to be different from the fluviatilis, even if it did not possess characters sufficiently distinct to form a new and separate species.

It is impossible, from an individual specimen, to determine the average size of the species, as there is no criterion by which to distinguish an old from a young fish. On this part of the character therefore I can only say, that the specimen in question measured twelve inches in length. The back is lead blue, gradually becoming lighter at the sides, the belly being of an argentine brilliancy; while the colour about the mouth and throat is the same as that of the upper parts of the fish. The first dorsal fin is angular on the margin, and is not above a third part of the second in length; this being rounded at the angle and continuous with the caudal fin. There are no spots about the mouth. The iris is white. The spiracles are of an oval shape, and are nearer to each other than in the P. fluviatilis. The mouth is furnished with numerous teeth, which, as in the P. marinus, differ in size, the largest being situated beneath the opening of the throat. They are of a yellowish white colour, the palate, like the back of the animal, being of a lead blue. They are disposed in two irregularly circular rows, with an additional portion of a row on the upper part of the palate, besides a single tooth immediately above the opening of the œsophagus. Immediately below the same opening, are three bony and blunt bodies, the middle one being the largest, and below these a long semilunar one; all of them being withdrawn into the throat when the circle of the mouth is not in action.

On comparing the characters now enumerated, with those of the only other species with which it could be confounded in description, it will be found to differ

from the P. marinus in having fewer teeth, in the presence of the bony bodies which surround the throat, in colour, and in the absence of the dorsal stains.

In size it approaches to the P. fluviatilis, which it also resembles in the proportion and disposition of the fins; but it differs materially in the absence of the *annuli*, in the greater number of the teeth, and in the number and forms of the bony bodies which surround the opening of the throat.

With regard to its distinctions from the remainder of the genus, they are so numerous as to require no notice.

From the situation in which it was taken, it might be considered as a parasitical fish; particularly as the P. branchialis is in the same way found attached to other fishes. But the evidence is too limited to justify such a conclusion.

The following definition seems necessary to distinguish it; although, without so tedious an enumeration of characters, its figure and habitation would serve to prevent it from being confounded with those to which it approximates in verbal description.

P. Ordinibus dentium plurimis; quatuor majoribus obtusis prope fauces; corpore non annulato; pinna dorsali posteriore caudæ adherente.

From the place where it was found, it may be called Petromyzon Juræ.

Some marine animals occur in these seas which remain still unrecorded in the catalogue of British zoology. Among these indeed it is probable that a few will be found still undescribed by naturalists; since fresh additions are even yet occasionally made to our catalogue of these obscurer parts of the creation. Many of these animals have occasionally fallen under my notice, but amid pursuits which rendered it impossible to attend either to their examination or preservation. I have however preserved a memorial of one, as it appears to form a new species in a tribe of which no individual has yet been

observed within the limits of the British seas. It belongs apparently to the genus Salpa, and the accompanying drawing would be sufficient to distinguish it even without a specific definition.*

The mode in which the *republic* is linked together, is observed to be constant in each species; and it is sufficiently remarkable in this one to distinguish it from the rest of the genus as far as it is yet described. Each individual adheres to the preceding by a regular sequence of superposition lengthwise, so that the whole forms a long simple chain; the adhesion continuing, as in the ovarium, for some time after hatching. They were found from the middle to the latter end of August, and always linked together. It is probable that their separation takes place at a later season of the year, but I did not observe them in that state. The individual is among the most simple in shape of those yet described; presenting an oval-lanceolate and slightly rhomboidal flattened figure, without appendages. The anal opening is of a bright brown colour and circular, being placed at some distance from the extremity; and when the chain is linked together, all these apertures are directed the same way. The animal is perfectly hyaline and tender; and the adhesion of the chain so slight that the individuals are easily separated. The act of swimming is known to result from the introduction and emission of water by each animal; and as the republic swims together by an undulating motion resembling that of a serpent, the chain often extending to many feet in length, it is evident that this motion must arise from the unequal manner in which the different individuals act throughout the whole line.

The species now described is most analogous to the S. polycratica and to the S. confederata of Forskahl. It differs however from the former in the want of the caudal denticle, in its hyaline appearance, and in the absence

* Plate XXIX. fig. 2.

of the rigid portion which attends that one. From the latter it is as readily distinguished by its longitudinal concatenation; since, in that species, the individuals adhere by their sides, so as to form a row in a lateral direction; while there are at the same time important differences in the structure of the two.

I had occasion to remark of this animal, that, like the Medusæ and analogous tribes, it cannot bear to be confined in a limited portion of water; as it died, even in the ship's bucket, in less than half an hour; a very remarkable circumstance in the economy of these imperfect animals.

Hitherto, this genus is only known as the inhabitant of hot climates and of the Mediterranean sea. I found it in great abundance in the harbours of Canna and Campbelltown; rising to the surface in calm weather, and crowding the water, as the Medusæ often do at the same time of the year. It may be called Salpa? moniliformis, and defined as follows:

S. Ovato-lanceolata, ano fusco, absque appendice terminali.*

I was desirous of observing whether this animal, like many other of the marine worms, emitted light, but had no opportunity of ascertaining the fact; as they seemed always to retire to the bottom at sunset, and those which were taken on board died, as I have already observed, in a very short time.

The phenomenon of luminous water is exhibited throughout these seas during the autumnal season with great brilliancy; increasing with the appearance of the Medusæ, and diminishing when they disappear.

This fact has been known to naturalists, at least since the

* The difficulty of distinguishing the several genera of mollusca which resemble this, and the obscurity in which the subject is still involved, render it necessary to speak with hesitation concerning the genus of this animal. The present description, although imperfect, will nevertheless suffice to point it out to the attention of naturalists.

days of Pliny, and has at different times been a subject of much discussion. Being too remarkable to have escaped the notice of even the most common observers, and too difficult of explanation not to have excited the ingenuity of philosophers, different theories of the cause have accordingly been proposed. Among mariners, it has, like all the less common phenomena of the elements, given rise to unfounded prognostics relating to atmospheric changes; while, like those which excite surprise from their rarity, or admiration from their singularity and splendour, it has been occasionally ranked among the recondite and inexplicable appearances of Nature. For this reason perhaps the investigation of its true origin has been neglected. Mariners and fishermen have always considered it as a property attached to sea water, and to that under particular circumstances of approaching change. Had their attention been directed to its real cause, we should long ere this have been acquainted with many more of the animals in which it principally resides; and have been enabled to extend the scanty list here given, to an indefinitely greater number; perhaps to all the inhabitants of the ocean. It is equally to be regretted that naturalists also have too generally taken it for granted that the property of yielding light was attached to the water of the sea itself; and that, instead of examining into its real seat, they have been content to speculate on its cause. Thus it has by one class been attributed to the putrefaction of sea water, although the slightest acquaintance with this element will show that, except in a few rare cases described by navigators, the waters of the sea do not exhibit appearances of putrefaction. On the contrary, provision seems to have been made, in the sea as in the air, for the speedy decomposition and dissipation of all dead animal matter; and for the incessant renewal in it of an uniform purity, similar to that which the winds, and other causes, effect in the atmosphere. Others have supposed this light to be phosphoric; a term to which no

definite idea was attached; and which has thrown no further light on the question than that usually arising from the substitution of one word for another. Mayer, and those who followed him, conceived that the water of the sea imbibed light which it afterwards discharged. It is scarcely necessary to mention the speculations of those who conceived it to be the result of electric friction; since a consideration of the laws of electricity would have shown that electric light is never produced in any analogous case. A more accurate investigation of the subject would have suggested that which the researches of recent zoologists have at length proved; that the luminous appearances in sea water were independent of the element itself, and arose from the phosphorescent property of living animals, or of animal matter diffused through it. Many distinct animals possessing this quality have been ascertained by the various naturalists who have accompanied the late voyages of discovery; and the subject having lately excited attention, many others have also been recently observed on our own shores. Had it been generally understood that this splendid phenomenon was a property possessed by the inhabitants of the sea, and not by the water, there is little reason to doubt that the researches of naturalists, like those of fishermen, would not only have extended our knowledge of the luminous individuals, but have perhaps ere now ascertained the peculiar chemical and vital powers to which the appearance is owing. It is true that a few persons have not only doubted the existence of this power among marine animals, with the exception of two or three species; but have fancied, that although the property of giving light was proved to reside in some of these, yet the general light of the ocean was the result of some hidden property in the water itself. After enumerating the luminous species which have been unquestionably ascertained, it will be seen that they are much more abundant than has been generally imagined; and it will also appear that even the light of that water

in which these animals do not exist, is originally derived from the same source. This list will be found at least as large as could have been expected, when we consider the small number of observers, the difficulty of the circumstances under which the observations are made, and, still more, the neglect which the subject has experienced from the causes already stated.

In the class Crustacea several species have been found luminous; as the Galathea amplectens of Fabricius, observed on the coast of Brazil by Sir Joseph Banks, and the Astacus fulgens of the same author; besides several genera of the family Gammarideæ, according to the observations of Hablitzl and Professor Jameson. In the genus Beroe, now included in the family of the Medusæ, the fulgens has derived its name from its luminous quality; and I am further informed by Mr. Giesecké, that he has observed many different and unknown species of this genus on the coast of Greenland, which are not only luminous when alive, but retain this property when broken to pieces by the surging of the sea; scattering a splendid and iridiscent light over its surface. The same naturalist has described another lucid animal hitherto unnoticed, which he calls Cyclops brevicornis (Monoculus brevicornis?) and Riville has made us acquainted with another also of this tribe, possessing the same property, which he has called the Monoculus lynceus; but the true Monoculus lynceus (the Lynceus brachiurus of Müller) inhabits fresh water.

There is no question that the Nereis noctiluca emits light, since it has been examined by many observers. Having also been nearly the first species ascertained to afford this appearance, it has probably been one cause of the neglect which naturalists have shown of the other luminous animals; every effect of this nature being ascribed to it, and the investigation of the individual consequently neglected. Another marine crustaceous animal, under the name of Limulus noctilucus, is described as luminous in

the voyage of Captain Horsbrugh. Monsieur Peron has also described in very splendid colouring a newly discovered luminous animal which he calls Pyrosoma atlanticum; and it has more recently been ascertained that the whole of this genus is endowed with the same quality. From Spallanzani we have an account of four luminous Pennatulæ; the phosphorea, grisea, argentea, and grandis; and he further mentions five luminous marine worms of which he has not ascertained the genera: it has since been remarked that all the Pennatulæ possess the same property. Among the worms which inhabit shells, the Pholades have also been observed to exhibit light.

But amid the various tribes of zoophytes, the Medusa is that in which the greatest number of luminous species has been ascertained; and of these, many are natives of our own shores. The hemispherica and scintillans have been described by Mr. Macartney at some length, but he appears to have supposed this property much more limited than it will actually be found. On the shores and in the deep bays of the Highlands, particularly in the autumn, many distinct species of this tribe are to be seen in great abundance; all of them shining with such splendour as to enlighten the sea around. The Medusa pellucens has been described as luminous by Sir Joseph Banks, the noctiluca and densa by Forskahl, and two others of the tribe, of which no specific characters are given, are mentioned by Forster and Spallanzani, the former at the Cape of Good Hope and the latter in the Mediterranean. In Captain Tuckey's recent voyage we are informed that a species of Salpa and one of Scyllarus were determined to be luminous, and that the same property was observed in many animals of the genera Beroe and Holothuria. Twelve crabs are also mentioned as possessed of it, besides the Lancer (Astacus) fulgens, formerly ranked among the luminous animals.

This enumeration, as far as I know, includes all the marine worms which have been fully ascertained to be

luminous, and of which the species of some, and the genera, at least, of others, have also been determined. But the phenomena observed by navigators on several occasions, prove that animals of similar powers, whose nature has not yet been investigated, abound in various parts of the ocean. Cook, Perouse, Riville, Horsbrugh, Newland, Langstaff, and Tuckey, have all described appearances of the sea in which it was perfectly and permanently luminous; resembling, in some of the instances noted, a vast plain of snow, or a sea of milk. Many of these observers have ascertained this appearance to be produced by minute animals, the nature of which however has not always been described. It is probable that various animals have been seen by these several persons, and that an investigation of the individuals would have added many more to the enumeration here given.

The twinkling appearance that characterizes the light of these worms, has been seen in water free from any visible objects, if we may rely on the care and accuracy of the observers; with this only difference that the sparks were more minute. Hence it was concluded that the water was in these cases luminous. Three circumstances may have led to errors in these observations. The slippery nature of the larger Medusæ causes them frequently to escape when an attempt is made to lift a vessel of water from the sea. The transparency also of the minuter creatures enables them to elude a cursory observation; and there is every probability that animals nearly microscopic, or resembling in dimensions some of the Infusoria, whether in the state of spawn or fully grown, inhabit sea water; possessed of the same voluntary powers of emitting light, and forming the prey of the tribes immediately larger than themselves: the observations of Forster seem to confirm this notion. It is to these unascertained beings that our attention ought to be directed; and there is little doubt that future investigations will still detect many unknown and minute animals possessed of this

property. The third and last cause which has tended to deceive naturalists and conceal these animals from observation, is that property which so many marine worms possess of speedy solubility in sea water after death. The small time occupied in effecting the solution and total disappearance of even the larger kinds, gives reason to suppose that the smaller have often eluded investigation from the extreme rapidity with which they undergo this process; a supposition the more probable, when we consider the circumstances under which these examinations are generally made.

With respect to the nature of the light, it is important to remark, that it appears in two distinct forms, and in these cases apparently arising from two sources. The twinkling appearance seems always to proceed from the animals, and to be the result of their own actions. It takes place when the water is at rest, and is much brighter than the light produced by merely disturbing the water where these are not present. On examining them, they are frequently found covered with luminous points; and it was ascertained by Professor Smith, that the seat of the light in one species of Cancer was in the brain; while it was apparently also under the influence of the animal. The fainter diffused light appears to originate rather from detached luminous matter dispersed through the water. This appears however to abound exactly in proportion to the number of marine animals present; and hence it is so remarkable in those seas where the worms and insects are most plentiful. This matter seems often to be the cause of the light produced by friction or agitation; although it is certain that the same disturbances also cause the marine animals to give out their own light. To Professor Smith it appeared that this substance consisted of solid spherical particles; but it may be questioned whether these were not rather animalculæ, or perhaps the ova of the worms or insects which were present.

It is next necessary to inquire to what extent this

property is possessed by the fishes, the larger and more perfect of the marine creation. Few direct observations on this part of the subject are to be found; and much greater intimacy with the almost unattainable inhabitants of the deep than my own, would be required to determine in which and in how many species this power exists. I have hitherto observed it only in the Pilchard, the Sardine, the Whiting, the Mackarel, and the Gar: but have little doubt that it is far more widely diffused. Some observations recorded by navigators seem to strengthen this notion of its greater extent. It has been remarked, for example, by different navigators, that the genus Squalus shines at night; and the flying fish has also been observed to emit a pale light, which Captain Ross compares to that of the moon. We are further informed by Anburey, that the porpoise in the river St. Laurence is luminous; and the same has been observed respecting many of the larger fishes on the shores of St. Helena, the names of which I have not been able to procure. Thus also, great flashes have been described as seen at a considerable depth in the sea, a phenomenon which I have often witnessed among the Western islands; and Pere Bourzes mentions luminous vortices observed by himself; appearances in all probability arising from the action of large fishes, although suspected by some to be produced by the larger Medusæ It is true that a deception may occur in these observations as to the true seat of the light; since the disturbance produced round the body of the fish by its own motion, might be followed by the luminous action of minute creatures, or of diffused luminous matter in contact with it, instead of originating in the animal itself. The probability however that fish actually possess this property, is strengthened by our knowledge of the light they so readily yield after death; a phenomenon by no means connected with putrefaction, but independent of that process. Whether however it be proved or not, that the larger fishes are luminous, the consequences

to be deduced from this phenomenon will not be materially affected; as they will be the same whether the light generated by the actions of the several tribes be internal or external; whether it be a property residing in the body of the animal, or liable to be called into action from without, by collision against the bodies of other animals, or against the luminous mass of the sea.

Although some labour has been exerted in attempting to ascertain the nature of the phosphorescent power, or the substance in which this property resides, no real light has hitherto been thrown on the subject. It is however known that it can exist independently of the animal by which it is generated, that it continues attached to the body after the principle of life has ceased, that it can even be separated in a state of mixture or combination with the mucous secretions, and that it is in this state diffusible through the sea, communicating to it the luminous property. Thus far then it is, in some cases, independent both of the principle of life and of the action of animal energy. We have therefore reason to conclude that it is an animal secretion, and consequently a chemical substance, of which the nature and properties are subject to investigation.

From these several facts it may be deduced, that the property of emitting light, so far from being confined to a few species or genera, is widely diffused among the more imperfect marine animals, and that it occurs even among the higher orders of fishes. On our own shores, it appears to reside in almost all the marine worms, and is, for evident reasons, particularly conspicuous in those which are produced in the greatest abundance and which swim nearest to the surface. The Medusæ therefore are, with us, the glow worms of the deep; emulating in dark nights, by their brilliancy and intermitted sparklings, the more distant lights that spangle the sky, and illuminating in a sensible degree the darkness of the ocean. There appears no foundation for the popular belief that this

appearance is the result of atmospherical changes, and that an universal brilliancy of the sea is the common forerunner of a storm. Such changes may indeed cause the animals to change their places with respect to the surface; but agitation of the water, whether by the motion of a boat, of a net, of a fishing line, or of the waves themselves, will excite the light at any time, and thus alone it appears connected with boisterous weather; not as a forerunner, but as a necessary attendant on the disturbed state of the ocean; affording, in gales of wind and in other favourable circumstances, the splendid, and, to landsmen, the terrific appearance of a sea of fire. If any further observation were requisite to confirm the opinion that this appearance was not connected, either with future changes of weather, or with any property inherent in the sea itself, it would be sufficient to remark that it is most conspicuous at those seasons of the year when the Medusæ are in greatest abundance. This is in the autumnal season, when our bays and shores abound with the animals of this tribe, provided apparently by the arrangements of Nature, for food to the migratory fishes which then visit them; but which, like the migratory birds, retire on the approach of winter to other seas or milder climates. The luminous appearance of the sea diminishes with the disappearance of the Medusæ, and seems to keep pace exactly, with the decay, or with the migration or sinking to the bottom, of these prolific animals.

With respect to the causes by which this light is excited, or the circumstances under which it is elicited, it has appeared to be invariably the result of the agitation or disturbance of the animal, as it is of that of the sea when the luminous matter exists in a detached state in the water. But it seems also to be the effect of a volition on its part; whether this be the consequence of fear, or of some other motive. When the sea contains Medusæ, although perfectly still, a frequent twinkling of the lights is always to be seen; appearing and disap-

pearing alternately, and probably, in consequence of the will of the animal. That it is the result of the will, is indeed almost proved, since it can be produced by noises which are capable of exciting alarm without disturbing the water. The same is to be observed in the larger fishes. Thus if a noise be made by striking on the gunwale of a boat when a shoal of pilchards is under it, the whole will in an instant become luminous, exhibiting the splendid appearance of a continuous sheet of light; momentary, but renewable on repeating the same alarming sound. It is impossible at present to ascertain the means by which this effect is produced. That it is not the result solely of their impulse against luminous matter existing in the water, whether dead or living, is certain; since the same effect cannot always be produced at those times by other agitation. Possibly the luminous matter may exist in the mucous secretion of the skin, and thus be capable of excitation by the mere effort of violent motion and consequent impulse on the water, in cases where this matter does not exist in the sea in a detached state. No explanation has yet been given of the power by which the luminous land animals obscure their light; yet in them it is equally known to be under the direction of the will, and also to be connected with essential purposes in their economy. The property of emitting light has been indeed supposed to be more common among those than among the marine tribes, and it has been found to exist in the genera Elater, Lampyris, Fulgora, Scolopendra, Pausus, Limulus? Galathea, Lynceus. The slender enumeration of the marine animals already given, is sufficient to prove that it is possessed by a much greater number even of species among the inhabitants of ocean; and the superiority of the several races themselves is numerically such, that while, in a few climates, the twinkle of an insect is occasionally seen, the nocturnal darkness of the immense ocean is illuminated by its inhabitants. In the insect tribe, it has been supposed to serve only for a

warning to the male sex, though in the Lampyris, Fulgora, and Elater, both sexes give light: in the marine animals it appears conducive to ends more universal, if not more important; namely, to the general communication of all the inhabitants of the sea, for the immediate object of self-preservation.

From the experiments of Bouguer it is deduced that the transmission of light through sea water is diminished in a ratio so rapid, that at the depth of 723 feet it ceases to be transmitted any longer. It is doubtful whether these experiments are capable of determining so delicate a question with such accuracy, yet the conclusions here to be drawn from them will be the same, although that depth should be far greater than the limit thus obtained. At a certain depth therefore, which, if required, may be admitted to exceed this three times, there is absolute darkness. But this is by no means the limit in depth of the inhabited ocean. Innumerable fishes are known to exist in depths far greater than this, and to pass at least a portion of their time in regions to which light never penetrates.* Here they wander and prey; and here apparently many tribes retire in winter, for reasons which have not been discovered; although the fact is well known to fishermen, who attribute it to the superior warmth of the deeper water. In our own seas of little depth, many fish are known to feed only by night; appearing, like beasts of prey, to sleep during the day. It is not to be supposed that the regions of absolute darkness in the ocean are uninhabited, since we are certain that they are frequented by the pelagic fishes, and probably by numerous species yet unknown to us. Nor is it possible that those which prey, either in these depths, or

* In his recent voyage to the Arctic sea, Captain Ross brought up shrimps by the sounding apparatus from a depth of 420 fathoms. Many other animals of inferior organization were found at far greater depths. These are unquestionably the prey of others, and the former, it is probable, that of the whale.

during the darkness of night in our more shallow seas, should be enabled to discover their food without the aid of light, which even in these minor depths must entirely disappear during the night. To supply this want, the property of phosphorescence seems to have been conferred on this class of animals, and apparently, in the greatest degree on those whose astonishing powers of reproduction, and whose insensibility, nearly approaching to vegetable life, seem to mark them as having been principally created for the supply of the more perfect tribes. In these also, as well as in the larger fishes, the phosphorescent property may serve for enabling them to pursue their own prey as well as for disclosing themselves to their pursuers.

The economy of the northern whale is in some degree connected with this subject, and seems to add a further proof of the truth of the views here held out. In the latitudes which this animal inhabits, it can often have no guide but the light of its prey or that of its own body; although the occupations of the whale fishers during the summer, in the time of perpetual light, do not permit them to observe the luminous appearance of the water, and we are unacquainted with these regions during the darkness of the polar winter. But the great depth of the sea which it frequents, as determined by the observations of the recent navigator above mentioned, together with the circumstance of its well known food being found at the bottom as well as at the top of that sea, are sufficient to prove that even in summer it must occasionally feed in regions inaccessible to light.

I may add to these general remarks, that the luminous property of dead fish, is perhaps calculated for similar wise ends to those already mentioned. These, sinking to the bottom of the ocean, become capable of attracting the attention of the deep-water fishes; answering the double purpose, of food to these tribes, and admitting the removal, as in the air, of carcases which might produce,

even in those depths, inconveniences similar to those which bodies in a state of putrefaction cause on the surface of the earth. It is also not improbable that the desire which fishes appear to show of following luminous bodies, arises from this natural instinct.*

It has been remarked that those seasons in which the water is most luminous, are most favourable to the herring fishery. This may be explained by the circumstances above detailed; since the pursuit of the Medusæ appears, no less than the choice of places for spawning, to be a motive for the migration of the herring, and for its apparently capricious change of haunts. There is little doubt that these animals form a principal part of its food; and were it not for the false notions of seamen on the subject of luminous water, the fishermen would probably derive advantage from following those indications which they now neglect. But it is not surprising that this circumstance should have been overlooked, when it is considered that the natural history of the herring is still involved in almost absolute darkness.†

* That some such notions as the preceding have prevailed, we have a proof in a very outrageous simile of Cowley, where he compares his mistress bathing, to a light: the quotation may amuse the reader who is not conversant with the metaphysical poets.

> "The fish around her crowded as they do
> To the false light that treacherous fishes show."

† It can admit of no doubt that the Medusæ are eaten by the superior classes of fish, as they are frequently found with portions torn off; and the coal fish, which swim near the surface, may often be seen engaged in this operation. Yet the animal matter which they contain bears a very small proportion to their bulk. In some rude experiments, made at sea, on boiling down an hundred pounds of Medusa cruciata, no gelatine was obtained, and but a very small portion of coagulated albumen. The residue was almost entirely sea salt. Those were purposely selected of which the stomachs were empty. It is probable therefore that, with the exception of the small quantity of fibre in their swimming muscle and stomach, they consist entirely of a very fine cellular membrane, minutely divided and filled with water. As Philip II. imagined of fish in general, they seem little else but coagulated water.

It is almost unnecessary to say to those acquainted with the fisheries on our different coasts, that Pennant's account of the migration of the herring shoals is purely visionary; nor has any more recent writer succeeded in reconciling, by any general theory, the several periods of its appearance in different places, or its difference of condition at the same time on different shores. The subject is of great importance in an economical view, exceeding indeed in that respect most departments of natural history, and highly worthy the attention of a naturalist. It is also far from being so inaccessible as seems to be imagined; since a large collection of facts on the subject might be obtained by any enlightened observer who should turn his attention to it.

It is at any rate certain that the herring breeds in the bays on the west coast of Scotland; as the young fish are found throughout that sea immediately after their exclusion. They do not therefore arrive from the arctic seas as Mr. Pennant imagined. Neither, on their first arrival, do they come in shoals. On the contrary, they are so scattered that they cannot be taken by the net in the usual way. At that time they are often caught in considerable abundance by a fly, or any bright substance; often by new tinned hooks, which they seize with great avidity; presenting both an amusing sport and a profitable occupation, as one man has been known thus to take a barrel and a half during the few days this fishery lasts. So far from their being migratory to the extent supposed, it would also appear, on the contrary, that their residence is in the deep water all round the northern coasts of Britain; since throughout nearly the whole year they are taken by the deep sea fishers; forming the most profitable and steady branch of this fishery, for a long time exclusively possessed by the Dutch, but now much followed by busses from Scotland; of the commerce of which, the taking and the exportation of the herring forms an important branch.

From the deep water they arrive early in the summer on the western coast, but are rarely taken in abundance till August, recently, not till September. On the eastern side of the island they are later, but extend much further along the shore; while, of late, they are also much more plentiful on this than on the former coast. This change of haunts is one of the most obscure points in the history of the herring. It has visited and deserted in succession almost every loch on the west coast; and in those which were once the seat of the fishery, not a fish has for many years been taken. At present they seem to prefer the inlets of the Clyde; formerly, the northern lochs were most productive. With that change from the north to the south, the season of shoaling has also become much later. It is equally remarkable that when the boat fishing has ended on the west coast, from their desertion of the shallow waters, the most abundant fishery is generally found on the eastern; although these are evidently not the same shoals, since the fish are in a different state. When the herring fishery was expected to prove a mine of wealth, expensive establishments were formed on the north-west shore, as was noticed in describing Tanera; all of which have for many years become useless.

There is similar obscurity respecting the periods of spawning, which appear to vary on the different coasts; although supposed, from its importance, to be an unvarying circumstance in the habits of animals. It may possibly arise from their breeding more than once in the year, and from that process being at different seasons performed in different places, according to the variations of circumstances which we have no means of ascertaining. Thus only does it appear possible to explain the different conditions in which they are taken at the same time on different coasts; and the greater confusion which occurs by occasionally taking fish in the same place in all conditions. In the western fishery they are always empty and in a high state of feeding; being thus much more valuable

in the market, while on the eastern, at the same period, they are full, and far inferior in quality. In comparing their excellence as an article of food, these would indeed be scarcely considered as the same fish. But I need not dwell on a subject at present so little capable of illustration: it is sufficient to have pointed it out to the attention of naturalists.

THE great regularity of the stratification of Jura cannot be understood without ascending to the summits of the Paps; and, to comprehend the whole as it deserves, it is necessary to ascend both the northern and southern mountains, since they alternately exclude the view of the ground beyond each other.* From Ben an oir on

* In ascending the Paps of Jura on my last visit, the heat was excessive, and, in this country, rare; the thermometer on the shore standing at 82° and on the summit at 72°. I may here point out the utility of a thermometer much less known than it merits, although by no means new; it is the best that can be applied to the purpose of observing the atmospheric temperature. In this, the bulb is no larger than the stem, and the scale is applied to the tube only, being a hollow cylinder of ivory. Thus the bulb is at a distance from the scale, and, when taken out of its case, is free from the action of accumulated heat. The facility with which the rays of the sun are transmitted through glass and reflected by polished metallic surfaces, enables this instrument to point out the temperature of the place in which it is, although exposed to the sun's rays: it seldom rises above half a degree when removed from a shady place into the open sunshine, and in particular positions undergoes no change, the stem forming a shade to the bulb. Were it in more general use, and due precautions taken against reflected and radiant heat by sheltering it from the action of the ground below and other approximate bodies, we should not receive from travellers such extravagant accounts of the temperature of hot climates; accounts which owe their origin partly to this latter cause, and partly to the heat accumulated in the scale by the sun's action. The heat in the sun would in fact be seldom found to be greater than in the shade. At the same time, the sensibility of this instrument is both amusing and instructive; since it is affected by every accidental breeze blowing over a surface colder or warmer than the observer's station, by its vicinity to

the one hand, and Ben shianta or Ben na caillich on the other, the whole island, if the day be clear, may be seen with tolerable distinctness; and the geologist will at the same time scarcely regret a labour, which, independently of this advantage, will be amply repaid by the extent and variety of the landscape. As the principal stretch of the island lies to the northward of these mountains, so the view from the northern part of the group is the most interesting; but from Ben an oir a general sketch of the structure and bearings of Isla will also be derived, and the ascent of this mountain is therefore as necessary for the investigation of that island as it is for the examination of Jura.

To those to whom geological investigation is yet new, it will not be superfluous to suggest the convenience that is derived from commencing the examination of an unknown country by ascending the highest places which it presents. It is often from such views only, that the general bearings and features of a country can be apprehended; and the geologist, who has perhaps expended weeks of toil in tedious pacing about the minor details of a country, often but partially exposed in the lower grounds, finds his difficulties vanish in a moment on viewing from the peak of some lofty mountain, the connexions and bearings of the strata detailed as in a map. This indeed is the point from which all his movements should commence, and here he should form the plan of his campaign; confirming, by the nearer examination

a surface in the act of greater or less evaporation, and by the passage of every cloud which impedes the radiation of heat from the surface of the earth. Those who have not attended to these circumstances will be surprised at the variations of temperature which it indicates when ordinary thermometers are steady. I must at the same time remark that there are cases where this extreme nicety would lead to inaccurate results; namely, in barometrical observations, and in geodesic operations with chains; where a proper adaptation of the sensibilities of the thermometer and of the objects to be observed, is required.

of the parts which he has marked for inquiry, those details of which he is generally enabled by this method to form a rational conjecture.

From the top of Ben shianta the stratification of Jura is exhibited in great beauty, and with a striking magnificence of natural perspective; presenting a scene of uncommon grandeur and effect. The general inclination of the beds is even and regular, while they rise from the eastward and are abruptly broken off towards the west. Hence, wherever they form hills, a continued range of their edges is seen, extending in a constant but interrupted succession till they vanish beyond the point of distinct vision. Thus they become all marshalled in straight lines, which, tending from several parts to the vanishing point, give the appearance of regular lines drawn by the hand of a painter; the breaks and interruptions disappearing in the general regularity of the whole.

Notwithstanding the apparent regularity of the dip of these strata, there are anomalies in it in various places. When the minute details of the angles of elevation are examined, it will be seen that they are not precisely the same every where, and that the strata consequently lie in an undulating plane. These irregularities are however neither considerable nor frequent; although they are such as to render it impossible to assign the precise elevation of the strata. Such an attempt is often indeed no less fruitless than difficult, as but little advantage can arise from a minuteness of detail in this respect. Ben shianta seems to afford a medium standard quantity; the angle of inclination being here twenty-seven degrees, and the dip, as nearly as I could ascertain it by the magnet, to the E. S. E.; the variation being taken at 26°. The direction of the strata in this mountain is therefore north north east. But from the occasional undulation of the lines of bearing visible in other parts of Jura, it is scarcely possible to assign the exact linear

direction of the whole mass of strata, as in Scarba and Lunga, and in the Slate isles; nor even to determine the predominant one. At the northernmost end of the island it is evidently continuous with that of the two islands just named, that is, N. half E.; but at the southern extremity it appears to become even more easterly than in the mountain above described; following, apparently, both here and in Isla, the direction of the northern part of the Slate isles, namely, N. E. by N. A similar flexure will therefore be found in Jura to that which occurs in Luing; and the great body of strata, here as in Isla, will probably be found conformable to the general direction of the primary stratified rocks on the mainland. The north-easterly direction appears to be the prevailing one, and the northerly but a temporary and limited deviation. It will immediately appear, on inspection of the map, that the outlines of the coast indicate such a direction of the strata; but I cannot speak with confidence of the bearings there laid down, as they are by no means easy to determine.

In describing the details of this rock and its accompanying strata, I shall commence with the central line of the island, as being the most simple, and as a point of constant reference for the rest.

This line, which forms the main body of the island, consists entirely of quartz rock. In various places, beds of micaceous schist, and of different conglomerates which are not strictly quartzose, are intermixed with it; but they are both of rare occurrence and in small quantity; the greater masses of these rocks being found on the eastern skirts of the island, or towards the upper surface of the great quartz beds. The thinner beds occur in different parts of the mountains, in Ben an oir, in Ben na caillich, and in Ben shianta, where their alternations with the quartz rock are evident; but they are even more numerous and more accessible in the northern and lower range of hills which reaches

toward Scarba. Various large sections of considerable portions are to be seen in these different mountains; from the examination of which, evidence is afforded of the stratified position of the quartz rock, even more clear than that arising from the general view of the island already given. The same places offer a ready means of measuring the angles of elevation, by the simple process of protracting the lines produced by the section of the beds, on a graduated scale. As the direction and position of the beds is best observed on these mountains, the most certain estimate can there also be made of their thickness. The quartz rock being found at the foot of the whole, extending to the shores of the sea on their western boundary, and maintaining its regular position to the summit, that thickness may be discovered by a simple trigonometrical process, and is found to be about 2200 feet. It is evident that the truth of this calculation rests upon that of the assumed constancy of the angle 27°, as well as on that of the barometric measurement; yet, under any supposition, these beds will be found to form a mass of considerable depth. They appear indeed rather to affect a more horizontal position in the lower grounds, and would therefore give dimensions greater than those obtained from the foregoing computation. These dimensions are countenanced by the corresponding scale of those which form the mountains of Assynt; and when compared with the extent of surface occupied by these, points out quartz rock as a principal member among the stratified substances of the primary class.

The thickness here stated must not however be supposed to extend through the whole range, which reaches from the northern end of Scarba to the Mull of Oe in Isla. On almost every occasion, stratified rocks are found to vary in dimension as they proceed; gradually wearing out into a thin edge till they disappear. Such deposits are, in fact, partial formations;

and are only entitled to the name of general because found in many parts of the globe under similar relations to the neighbouring rocks and to the crust of the earth.

The variations in the composition of this rock are considerable, but these are generally either conglomerates, or transitions to micaceous schist and to graywacké. But the simpler and purer varieties predominate, and Jura will therefore be found to afford very extensive examples of quartz rock in its most ordinary state. The surface of this rock is commonly white, but it rarely preserves that colour throughout the mass; exhibiting most commonly a grey, or yellow, or brown stain when broken. The varieties in which felspar predominates, are comparatively few. Mica, as an ingredient, is equally uncommon, and the transition to micaceous schist is rare; except on the upper surface of the total mass of beds, and consequently, on the skirts of the eastern shore. Occasionally, loose conglomerates of quartz, either simple or mixed with clay, are to be seen, and these generally occupy single and thin beds irregularly dispersed among the rest. In some cases they contain pebbles of considerable magnitude. In the upper parts of Ben an oir, a bed occurs containing fragments of various coloured quartz and of jasper; and in other situations, a conglomerate similar to that of Lunga and Scarba, is found, consisting of fragments of clay slate and of micaceous schist intermixed with the siliceous gravel and pebbles, and cemented by the finer sand of the quartz rock.

In approaching the eastern side of the island by descending from the interior elevated ridges towards the shore, the quartz rock gradually gives way to the various schists, which, in a general way, may be conceived to extend from a point near Ardfin to the shore of the Coryvrechan, where they correspond with those of Scarba. This line is however as irregular as it is undefinable; since the gradation resulting from the alternation of the quartz rock with the proper schists, is so fre-

quent as to render it impossible to point out a place where the former becomes absolutely excluded. Although the eastern shore of Jura may thus be said to be formed of schists, there is still a diversity in this respect in the characters of the northern and southern portions. From the Coryvrechan towards Lowlandman's bay, the appearances resemble so precisely those on the east side of Scarba, that it would be superfluous to describe them; the chief alternations being those of clay slate with micaceous schist, quartz rock, and graywacké. In proceeding from Lagg ferry towards the south, the clay slate diminishes in quantity, yet is never excluded; as it is found even at the southern extremity of the island. But at the bay of the Small isles, the other schists begin to predominate, and further to the southwards the micaceous passes into chlorite schist and into a sort of talcaceous schist; these different substances occupying in a great measure the whole tract on the southern shore, from a point near Ardfin to the south-eastern angle of the island. The transition of the quartz rock into the micaceous schist and into the graywacké can be often traced; as may that of the micaceous into the chlorite schist; but the former of these may be considered the predominant substance in the south-eastern angle of the island. I may add that the somewhat rare variety of clay slate known by the name of drawing slate, or black chalk, is also found in this part of Jura.

The mineral characters of these substances offer no peculiar features. The clay slate is of the most ordinary aspect, dark blue and fine, sometimes fissile and yielding roofing slate. The micaceous schist at times contains quartz, while in other cases it consists almost entirely of mica. The graywacké possesses a much greater variety of aspect, since it presents every transition from a coarse conglomerate to a fine schist; passing at length into those varieties in which clay predominates, almost to the exclusion of the quartz and mica. Quartz veins

are very abundant, and they are also conspicuous for their magnitude.

One remarkable rock still occurs on this side of the island, offering an appearance somewhat anomalous, and at a distance, very deceptive. It consists of a graywacké basis, or a paste of clay slate and quartz, containing distinct and large particles of quartz and felspar which bear marks of irregular crystallization; the felspar in particular often presenting its well known angular sections where the rock is broken. At a very short distance from the eye it can not be distinguished from a porphyry, and for such it might readily be mistaken on a cursory examination. There can however be no doubt respecting its real place among the schistose rocks; particularly as approximations to it are not unfrequent among the schists of the adjoining hills. It is also disposed in beds regularly alternating with the others, while in many instances it loses the porphyritic aspect and subsides into an ordinary graywacké. Respecting the geographical positions relatively occupied by these several substances, it is unnecessary to enter into verbal details; nor indeed could they be rendered intelligible, from their intricate nature and from the dispersed state of the population of Jura, which affords few names of places adapted for the purpose of reference. The reader must on this subject consult the map, where the general positions are indicated as nearly as the state of things permits.

It is now necessary to return to the west side of Jura, which remains undescribed. There is nothing indeed to be said on this subject which would not be a repetition of the account of the central line of the island. The quartz rock here extends from the mountain ridge to the shore; commonly terminating in low cliffs, which stretch from the western entrance of the Coryvrechan to that of the Sound of Isla. In these the stratification is distinctly visible, but this side of the island

appears to present no peculiarities requiring further detail.

The trap veins of Jura are conspicuous both for their great size and continuous extent. It has so often been observed in the description of the preceding islands, that these veins were chiefly predominant in the vicinity of the large overlying masses of trap, and diminished in number as they receded from these, that the present exception appears unaccountable. It will shortly be seen that they are equally conspicuous and abundant in Isla; and it is further apparent that the same veins are prolonged between both the islands, their general correspondence being visible on the opposite sides of the sound that separates the two. It is further important to remark, that they are comparatively rare in the northern extremity of Jura, as they are in Scarba. Thus, in tracing them from that extremity of the island towards the south, they at first appear to diminish, according to all former experience in these islands, as they recede from the great mass of Mull and the Slate isles. It is not therefore without some surprise that they are again found suddenly to increase at the division between Isla and Jura; and to be there accumulated, as if diverging from some common central mass; both the opposed shores presenting a continued succession of them, very conspicuous for their size and for their permanence among the surrounding strata. An expectation is thus naturally excited of finding, either in one or the other of these islands, some extensive mass of this rock. None such, however, exists in either. But in the sound between the two, is found a small green islet, named Glas island, which might easily have passed unnoticed, as a fragment of the stratified rocks. This spot consists of trap, chiefly of an amygdaloidal character, containing nodules of calcareous spar and of heliotrope; a variety that does not occur among the veins. In examining the sea rocks in the vicinity, with the view of ascertaining the possible extent of this mass, they are all found to be of the same composition; and it is

thus proved that there is a body of trap in the vicinity of the veins, of which a considerable portion is now apparently concealed by the sea. The breadth of the strait is here about two miles; and although nothing like a proof can be offered, it is not improbable that a large portion of this space was once occupied by a rock which has in later times been removed by the action of the sea, or by other causes. In considering the revolutions which the surface has every where undergone, and of which this strait presents such palpable marks, in the correspondence of the strata on the opposite shores, it is not very unreasonable to suppose that Glas island is the last remaining portion of a more extensive mass, which might once have covered even the adjoining land on both sides, and have been the origin of the veins in question. The analogy between this spot and the Maddies on the shore of North Uist, is remarkable; and the same circumstance of the existence of corresponding veins, attends both. Thus also it may probably be concluded, that the central trap of Jura is the origin of the veins on the neighbouring coast of Cantyre, of which a very remarkable collection occurs at Killean, since no other neighbouring mass can be traced to which they can be referred. Those of the Mull of Cantyre may also possibly originate in the same source; unless Arran should here be supposed the central point from which these diverge. In a general view this fact is important, as it confirms the rule already deduced from former observations made in this country, respecting the connexion of trap veins with extensive masses of a parent rock. It serves still further to approximate the great trap district of the Western isles to that of Ireland; by interposing another point which conduces to diminish the apparent distance between two tracts of which the connexion may once have been much more intimate than it is at present.

With respect to the veins, separately considered, a very few remarks will suffice, as they present scarcely any appearances that have not been described on former

occasions. A considerable one is to be seen in Ben an oir, which divides naturally into very small prismatic concretions: in other situations they are occasionally foliated or of a schistose structure. They consist generally of a dark lead blue basalt passing to greenstone. Their permanence, after the surrounding strata have disappeared, often produces a singular effect; leaving them in the form of irregular walls high above the level of the island, and sometimes appearing, on the shores, like those in Mull, to be the ruins of ancient castles. They serve in such situations as registers, to a certain extent, of the waste of the land.

Fragments of porphyry are found scattered over the soil in several parts of Jura, indicating the probable existence of veins of that substance, none of which however fell under my notice.

Among the beds of chlorite schist, common scaly chlorite is sometimes found in nodules, a circumstance not uncommon in similar situations. Occasionally it is also found crystallized; an occurrence much more rare, and which I have not elsewhere observed except in the vicinity of Glen Tilt. The crystals are of considerable size, and present the complicated form so well known to mineralogists as occurring in that chlorite which accompanies the garnets of Piedmont. The quartz of those veins which traverse the chlorite schist, is occasionally found penetrated by this mineral so as to assume a dark green colour; a variety very common on the shores of the Clyde in the same circumstances, and generally mistaken for prase. This substance occurs abundantly in Borsel island, which presents a very accessible example of the intermixture of the different schistose rocks; offering an epitome of the neighbouring shore.

HAVING terminated the account of Jura, it will not be useless to give a general sketch of the history of quartz

rock, as no distinct account of it is to be found among systematical writers. This rock is found in various parts of Scotland, forming considerable tracts of country, and holding, in point of extent, the next rank among the primary strata to micaceous schist. Independently of the space which it occupies in the four associated islands, Lunga, Scarba, Jura, and Isla, it is found in the Slate isles in small quantity; forming there part of a series that occupies a large part of Argyllshire and will immediately come under review. In the northern parts of the mainland it forms a considerable tract, being very conspicuous in Ross-shire and Sutherland, where it rises into mountains of considerable elevation. It also occurs on this coast, further to the south, in several places, as in Arisaik and in Appin; but in limited quantities, the predominant rocks of this division of Scotland being micaceous schist and gneiss. A very extensive tract of it is found reaching from the southern shore of Loch Leven, and the boundaries of Glenco, to the foot of Ben Nevis, where it seems to terminate; alternating here, as in most other places, with micaceous schist, and, like that, reposing on granite. It is also to be found on the east side of Sutherland, and as already noticed, in Sky.

The next district in which it predominates, lies toward the east side of Scotland; where it may be traced from Ben Gloe in different directions over a considerable space. To the westward, it is seen stretching towards Rannoch, where it alternates with, and passes into, micaceous schist and schistose gneiss; thence tending to the southward it forms the highest ridge of Schihallien, and terminates at length in Glen Lyon. Eastward, it extends far through Mar toward the mountains of Forfarshire; while, in a northern direction, it is to be traced for a considerable space on the eastern flank of the granite ridge of Cairn Gorm towards Tomantoule. In several parts of this extent it is found to alternate with clay slate and limestone, as well as with micaceous schist; and, like all

these rocks, it occasionally lies in immediate contact with granite.

The external character which quartz rock gives to a country, and particularly to the high mountains that are composed of it, is remarkable, and leads to its detection even at a distance. Such hills are generally of a conoidal shape, but whether characterized by this remarkable form or not, they are bounded by a smooth flowing outline, rarely disturbed by the breaks and asperities so generally characteristic of mountains of micaceous schist. They are generally also covered in the steepest parts with heaps of fragments, on which no soil seems ever to accumulate; and as they undergo no decomposition, their nakedness and predominant white colour are seldom concealed even by the growth of a lichen. It is from this whiteness, often so dazzling in the sunshine as to emulate at a distance the effect of snow, as well as from their forms, that the composition of these mountains can often be conjectured. The accumulations of fragments render them also very difficult of access, and, in many places, preclude it altogether, without a degree of labour and risk which few are willing to undertake. Although these ruins bespeak the degradation of the strata, the disintegration of the rock is every where scanty; the soil which covers these mountains being consequently thin, and consisting of little else than sand mixed with a portion of the black earth that results from the decomposition of vegetables. Hence they form the most sterile of all the soils which Scotland possesses; and the same character indeed appears to belong to this rock wherever it has been observed. Where the sheep and the stag find little pasture, the botanist will also find but few plants to reward his labours.

The indestructible nature of most of the varieties of this rock, and the apparently eternal durability of those which consist of quartz alone, point it out as adapted for architectural purposes, although hitherto neglected. In many situations, as in Isla and Jura, it is of easy access; and,

from its stratified arrangement, is capable of being readily quarried. From the same cause it can also frequently be procured in parallel beds of various thickness; while, often possessing natural joints like many other schistose rocks, it breaks readily into fragments of a rhomboidal, if not of a rectangular shape, which admit of being easily trimmed by the hammer. The difficulty of producing a smooth surface by the pick, might possibly limit its uses to certain classes of masonry; but in those, the facility of giving it a form fit for building, would render it an economical substitute for granite, which it also far excels in durability. As a lining for furnaces it must also be of great use; undergoing no alteration except at the very surfaces of contact with the other earths which it may meet in the fire.

It has appeared from the preceding remarks, that quartz rock is a member of the primary strata. With regard to the precise place which it occupies among these, nothing positive can be laid down; since it is found alternating with all those which follow granite. But as the doctrine of an invariable order among these rocks is unfounded, it is no more subject to uncertainty than limestone, gneiss, micaceous schist, clay slate, or graywacké; among which it holds a place, and with all of which it alternates. In Scotland however it appears to occur most frequently in company with micaceous schist, with gneiss, and with red primary sandstone.

In many places it will be found to alternate regularly with micaceous schist; and it is well known that many rocks, generally ranked with this substance, contain but a very sparing quantity of mica, while their predominant ingredient is quartz in various states of mixture. Such varieties, holding an intermediate state between two rocks, have an equal claim to be ranked under either; but as it is a fruitless attempt to define that to which Nature has not set bounds, and as no advantages are gained by multiplying terms to express such gradations, it is most proper

to class the doubtful specimen in that division which is the predominant one, geologically considered. Thus the occasional presence of mica will no more exclude a specimen or a bed from the series of quartz rock, than the predominance of quartz will remove an occasional bed of the latter from the mass of micaceous schist in which it is situated. It is among specimens of this character, that the substance so much used in ornaments by the name of avanturine, is found; its colours varying with the hues of the mica and of the quartz, and the nature of its reflections and lustre depending, partly upon the magnitude and position of the scales of mica, and partly on the quality of the quartz which unites them. The progress of this substance may readily be traced from the coarsest micaceous schist to the most brilliant specimens, and numerous varieties of it may be found throughout Scotland.

But the alternations between micaceous schist and quartz rock are often more decided and on a larger scale; a sudden and complete change taking place where they meet. Scarba and Jura afford abundant examples of this nature, and it is also to be found in many other parts of Scotland. The space occupied by the quartz rock in these cases is so great, that it constitutes the chief part of the series, and cannot therefore be considered as subordinate to the micaceous schist. In many places indeed this latter substance is altogether wanting; large tracts of country, exhibiting strata of some thousand feet in thickness, consisting solely of quartz rock; giving it thus, as I formerly remarked, a decided claim to be ranked as a principal member of the primary class.

As micaceous schist and clay slate have been proved to alternate, thus quartz rock also alternates with this latter substance. The mode of this alternation, like that of the former, is various; the laminæ being of greater or less thickness. On a small scale these alternations are not unfrequent; between large beds they are rare. In some of these cases the same gradation occurs between those two

substances as in the alternations of micaceous schist with quartz rock; but in others, they are separated by a precise line. Of this latter variety, Jura and Scarba offer striking examples; the quartz rock possessing a well-marked and independent character, and forming a principal member of the whole; while the clay slate and micaceous schist alternate with it. Among these three substances there is consequently no decided standard of priority or posteriority; the irregular recurrence of the whole proving that each is, in its turn, the most ancient and the most recent.

As limestone is found to alternate with micaceous schist, it must sometimes possess the same relation to quartz rock, and it accordingly occurs in this situation in the ridge that forms Ben Gloe. No gradation however between the two substances has yet appeared, if we except the slightly indurated and siliceous nature of the limestone where they are in contact.

A more interesting alternation is that of quartz rock with graywacké schist, and in this instance its analogy with the secondary sandstones which so often follow that substance, is particularly apparent. Jura, Scarba, and Lunga, afford conspicuous examples of this association; but I need not repeat that which has so recently come under review. Sutherland produces numerous and obvious examples of the alternations between quartz rock and gneiss; the two rocks occupying extensive tracts of country, and forming some of the principal mountains of the north-western coast. This substance alternates also with the red primary sandstone, both of that district and of Sky, as I have formerly remarked in treating of the Sandstone islands.

It has been imagined that quartz rock also belonged to the secondary strata, because a compact stratified quartz is found accompanying the beds of coal in Fife. But these strata are intermixed with trap, and it was shown that in Sky the secondary sandstones often put on that character in similar situations. There is little reason therefore to

doubt that the stratified quartz of that coal district is a secondary sandstone, which has been reduced to that state in consequence of the influence of masses or veins of the trap by which it is accompanied.

The varieties in the mineral character of quartz rock are numerous, but I shall limit this notice of them to the most important and the best marked.

It is occasionally, but rarely, found in a compact state, and crystalline throughout; little differing from quartz as it occurs in veins; but even in these cases showing a constant tendency to divide in parallel beds. More generally, when pure, it has an aspect obscurely granular, which by degrees becomes somewhat lax and arenaceous; the grains varying in size and in the intimacy of their union. In some of these examples it appears to be a granular crystallized mass; in others it possesses a mixed mechanical and chemical texture; while in a third, the rounded aspect of the grains, and the small number of the points of contact, appear to indicate an origin chiefly mechanical, and resulting from the agglutination of sand. These are its varieties when in the purest state; and I may add, that cavities are sometimes found in the specimens, containing regular, although minute, crystals.

The next, and perhaps the prevailing, variety of this rock, consists of a mixture of quartz and felspar; and from the latter it generally derives a reddish hue. Its texture is various, the grains of felspar being at times imbedded in a crystalline quartz, while, more frequently, the whole rock is a mass of agglutinated grains of the two substances, in various proportions and of various sizes. In every instance it has a foliated disposition; and, sometimes, even the texture is the same, since it splits into laminæ of extreme thinness.

The next most remarkable variety is that in which the quartz is intermixed with mica, but I have already said all that is necessary on this subject when treating of its alternation and affinity with micaceous schist. I may only add,

that, in these cases, it often admits of being split in the direction of the micaceous laminæ, into large flags applicable to the purposes of architecture.

Tracing the progress of the granular kinds, we find them at length consisting of grains so large as to appear mere agglutinations of gravel, with occasional vacuities among the grains; nor is it uncommon to find specimens containing rounded pebbles of large size. In these varieties the marks of mechanical formation are obvious; and they are rendered still more so by the occasional intrusion of dissimilar fragments, such as jasper, clay slate, and micaceous schist, examples of which occur so as to form considerable beds both in Scarba and in Jura. From these, the passage into common graywacké is easy, and, in these islands, abundantly obvious.

Such is a general sketch of the prevailing mineral features of quartz rock. Respecting its accidental characters it may be added, that it is a metalliferous rock, although not hitherto included in that division; since the mine of Tyndrum is situated in strata of this substance that alternate with micaceous schist. Occasionally also it contains those prolonged concretions and other well known forms which are common in the secondary sandstones, and which have been supposed in these to originate in organic remains or impressions. Finally, I may remark that it is rarely contorted, when compared to those rocks with which it is associated; although instances of such irregularities may be witnessed in some places, and very conspicuously at the Whiten head in Sutherland.

ISLA.*

ALTHOUGH the geological interest of Isla is not proportionate to its magnitude, and its physical structure has been very much anticipated in the account already given of the other islands of this chain, it is nevertheless highly worthy of investigation. By exhibiting the phenomena observed in those islands in a different manner, and by adding considerably to their geographic extent, it confirms the preceding remarks, and removes any doubts which might have arisen from imperfect or deficient observations. It displays at the same time some other appearances, tending, not only to throw light on several facts already described in different parts of this work, but adding something to that mass to which they have already contributed.

The greater part of the surface of Isla being even, or swelling into gentle undulations, while the ridges of hills which skirt it toward the east and west are of moderate elevation, it offers but little attraction to the traveller whose pursuit is picturesque beauty. The coast line is in general equally void of character; being bounded by low shapeless rocks or by flat shores and sandy bays; with the exception of a very few points which present considerable faces of broken and abrupt rock. But all beauty in nature is not necessarily picturesque; and to him whose taste is not exclusively confined to that which alone is the province and pursuit of the painter, Isla affords many attractions. Yet it is not absolutely void of objects worthy the attention of the artist, since the [redacted]arthur's head and of the Mull of Oe, present [redacted]nsiderable grandeur, in the forms and colours [redacted] rocks, intermingled with grassy slopes and

* See the Map of Isla and Jura.

enlivened by the surge of the lon
even in calm weather breaks at th

The traveller who chances here to commence his career among the Western islands, expecting that new manners will meet his view, will be disappointed to find in Isla, little in the habits of the people, or in the aspect of the country, different from that which he has left behind. Circumstances have much changed even since Pennant wrote; a few years having, under the influence of wealth and intelligence, done much towards effecting that change which it is to be hoped will ultimately take place through the remoter tracts of this neglected country. In investigating the causes which have accelerated the progress of Isla towards improvement, and in comparing them with those which have retarded and still retard that of the other islands of this sea, the economist will find ample room for reflection. From the occasional remarks on these subjects which have passed before the reader, he will already have been enabled to form for himself a general notion of these interesting parts of the history of the Western islands: more minute details would be incompatible with the object of this work.

Isla is of an irregular trapezoidal form, deeply indented at the south side by the great bay of Loch in daal; its extreme length being twenty-five miles, and its greatest breadth twenty, or thereabout. The continuity of its general outline with that of Jura, is rendered more impressive by that of the directions of the strata which form both the islands. The strait by which they are separated is narrow, and the resemblance of the opposite shores is therefore the more easily seen. So exact is the correspondence that we can almost imagine a recent fracture and separation of these two islands; just as [illegible] ceive the forcible disjunction of the high cli[illegible] each side bound the Coryvrechan. The sl[illegible] strait are abrupt but not high; rarely exce[illegible] dred feet, and seldom perhaps attaining t[illegible]

On the north-western side of Isla, the same character is prevalent for some distance; and the quartz rock is here broken into caves, of which one is remarkable for its capacity; the receptacle, in times not long past, of some families of the poorer inhabitants. These shores vary, without much interest, till we reach Loch Gruinart; a deep but shallow indentation, terminating in an alluvial plain where the sea and the land are now contending for supremacy. From this place to the point of the Rinns, there is as little interest as variety; low rocks and sandy shores succeeding each other without any change of character or features. A cave of considerable length, formed by a discontinuity of the beds of slate, occurs at Sanig, but, like many other caves found about the shores of these islands, it is unnecessary to describe it; since, though an object of curiosity to the natives, it possesses nothing either in a physical or picturesque view to render it interesting.*

The point of the Rinns is remarkable for the extreme violence and rapidity of the tides which run past it; scarcely less violent and fearful than the stream of Coryvrechan, and attended with currents even more difficult to explain. In the most remarkable case that occurs here, a narrow channel is formed between the body of the island and the two small islets Chenzie and Oersa, and in this strait the time of the ebb is ten hours and three quarters, that of the flood being but one and a quarter; while, on the outside of these islands, the twelve hours are, as in the open sea, equally divided between the ebb and the flood.

* Caves appear in all countries to be the objects of a curiosity mixed with awe; the seats of a mysterious terror. Among the prevalent opinions respecting them in the Highlands, is that of their extreme depth. There is none of which it is not said that a piper has entered without ever returning, the sound of his instrument having been heard gradually expiring in the prolonged vaults. One, near Dunkeld, is said to reach to Schihallien. Of another, in Sutherland, it is asserted, that whoever enters it will return without his skin.

The irregularity and intricacy of the tides throughout the Western islands in general, is very considerable; often indeed such as to defeat the calculations even of the mariner experienced in these channels. Although for the most part correctly laid down in the sea charts already so often mentioned, they are subject to variations for which these observations have not provided. The causes will be evident to mathematicians, when it is recollected that every tide is, here more especially, the result of a variety of concurring circumstances; some of which are liable to changes that do not admit of observation or calculation, and which therefore modify the others in various unexpected ways. The chief of these are, important variations in the direction and force of the winds, which, as they are combined with different lunar or annual states of the tide, influence in various modes the more steady causes which consist in the directions of the tide stream and the intricate forms of the channels through which it passes. In many places, situated even within a mile of each other, there are sometimes differences of two, or of three hours, in the time of flood or of ebb. An example of this occurs between the inner and outer channels of the Slate isles. In other situations, there are analogous differences in the quantity of the rise and fall. Thus, at Oban, the difference is sixteen feet, while in Loch Killisport it does not exceed two, and in Loch Tarbet is scarcely perceptible. In some places the flood arrives from the east or north; in others, on the contrary, it comes in from the west or south; it will even occasionally be found to flow in different and nearly opposite directions, in channels not far asunder, and not much differing in their general position with respect to the coast.

These variations are partly owing to the intricacy of the several channels which receive the stream that follows or precedes the tide wave; partly to the circumstance of a given channel receiving its tide from two sources, or from two portions of the wave. As these

may vary in the time of their arrival, there is thus produced in some cases a counteraction, in others a coincidence. In a similar manner, the situations of headlands divert the course of the stream: in some cases they receive the impulse of two streams, and there are thus produced still further intricacies, accompanied by those eddies and gyrations, and that breaking sea, which render so many parts of this coast dangerous to boats. An accurate knowledge of these tides is not unimportant to the geologist who may attempt the voyage of the Western islands; since, without it, he will often be defeated in his objects and find it impossible to reach the points which he is desirous to examine. At all times he is their slave, and can only defeat them by a watchful attention to their movements.

From the point of the Rinns, along the west side of Loch in daal, there is a succession of low rocks and alluvial land, terminating beyond Connisby in a large shallow sandy bay, which, with the exception of the rocky point of Laggan, is continued to the promontory of the Oe. Here, a range of high cliffs occurs, reaching round the Mull of Oe to Loudinas; the point of the promontory rising to a precipitous height of 800 feet or more, and presenting that scenery of which I have just made cursory mention. The eastern coast, as far as Ardtala, consists of a rugged line of low rocks, much indented, and beset with islands; the quartz rock here forming the higher and more precipitous shore of which Macarthur's head is the most conspicuous point, and which terminates in the sound whence this circuit commenced.

In describing the general surface of Isla, it will be convenient to divide it into regions, as this will not only render the geographic descriptions more intelligible, but conduce to a clearer understanding of the geological details. The first of these is determined by five points; Ru val, Loch Gruinart, Octofad, Isla house, and Portaskeg; and the peninsular division to the south of this may be considered as the second: the terms of north-western and south-

western being respectively applicable to them. The middle division may be defined by a line drawn from Kintra, along the foot of the eastern ridge of hills, to Portaskeg. If again a line be drawn from Ardtala point to Loudinas, it will divide the remaining eastern part of the island into two; the easternmost of which may be called the eastern flat, and the remainder and larger portion the eastern ridge. With this assistance the places referred to may be specified, without the necessity of having much recourse to the often dissonant Celtic and Scandinavian names by which they are marked.

The high and irregular land that bounds the sound of Isla, and is apparently continued from the opposite shore of Jura, soon divides into two ridges; the westernmost of which reaches to Loch Gruinart, while the eastern is prolonged, with an interruption between Laggan bay and Loudinas, as far as the Mull of Oe. The former is irregular, and of an elevation never rising to 1000 feet; while it gradually subsides towards the alluvial land and the middle division, by a series of gentle eminences; the whole constituting the division termed the north-western. The eastern ridge attains a higher elevation, many of the hills reaching to 1500 feet, or possibly more, with an aspect more rocky and mountainous than those of the western side. The northern parts of the middle division are characterized by irregular undulations and rocky eminences; while towards the bay of Laggan it passes by degrees into a great alluvial plain deeply covered with peat. The south-western division is skirted on the western side by a ridge of low hills, and descends by a gentle gradation to the sea on the eastern; possessing one of the best soils in the island, and in general exhibiting a continuous tract of well cultivated land. The division here termed the eastern flat, is an irregular tract, generally low, but every where interspersed with detached rocky eminences, so as seldom to present any considerable unencumbered space. It is also fertile, and is cultivated wherever the

plough can be managed; but the improved state of agriculture in Isla does not permit that sort of industry which consists in cultivating rocky lands with the spade, and which is so universal a feature throughout the islands where the ancient habits still prevail.

The soils of Isla are as various as the rocks on which they lie. The south-western division and the eastern flat are formed of rich and generally deep clay, sufficiently mixed with sand to adapt its retentive powers of moisture to the wet climate of the island. The middle division is in great part calcareous, lying on a tract of limestone; while in other places it is a clayey or gravelly alluvium; or, where the peat has been reduced by culture, possesses the quality usually derived from the predominance of that substance. These soils are also fertile, and are in general, either in a state of cultivation, or making as rapid a progress towards it as the circumstances of the island will permit. The two ridges, consisting of quartz rock, are, as in similar cases, covered with a scanty and gravelly soil, producing the usual pasture of all the mountain districts which lie on this rock. They are employed in the pasturage of black cattle; few sheep being reared in Isla, and those only for domestic consumption.

The circumstances which distinguish the agriculture of the Western islands have been occasionally noticed, and too often, it must be regretted, in terms of censure. These remarks do not apply to the system pursued in Isla, which, though as yet far from perfect, is advancing with a steady pace, and with a more rapid stride than the neighbouring continental districts did during their state of reform and improvement. By the enlargement of farms, and by the introduction of capable tenants acting under secure leases, moderate rents, and allowances for *melioration*, new lands have been brought into cultivation; while the introduction of green crops, the improvement of the breed of cattle, a better system of stocking and of winter feeding, roads, carts, improved

houses, and more perfect modes of fencing and draining, have produced their usual effects, and proved that, under similar management, the agricultural reform of these islands in general may ultimately be effected. The natural consequences have followed; an improvement in the state of the population, together with an increase in the value of the land, of which Scotland scarcely any where presents more striking examples.

Isla produces little for the amusement of the botanist beyond those plants which are common to all the islands, and which have rarely been enumerated in this work, since they are of almost universal occurrence along the western coasts, in boggy and rocky soils or in moderately alpine elevations. Two plants however, not very common any where, grow here in profusion; the Epilobium angustifolium and Ribes rubrum. A small lake near Kilmenny is remarkable, as well for the profusion of this latter plant which it displays, as for the remains of some of those ancient buildings of which Isla presents so many examples.

The extent of this island, and the great proportion which its open and fertile tracts bear to the barren and mountainous regions, when compared with the other islands of this sea that resemble it in magnitude, seem to have rendered it at all times more populous than any of the rest; if we except Iona and those already described which possess a fertile basaltic soil, namely Muck, Egg, and Canna. Hence it appears to have been more conspicuous in the history of ancient times; having been the scene of perpetual warfare; of invasion, conquest, and piracy. That importance is marked by its having been the residence of one of the great kings of the isles, Macdonald; respecting whom, all the notice admissible in a cursory sketch of this nature, has already been given in the account of Lewis. A record of the extent of its early population, when compared with that of the other islands, may be found in the much greater number of local

Danish names which it possesses. Such names are, in all the islands, derived either from the Scandinavian, or from the existing dialect of the Celtic, namely, the Gaelic, or Scoto-Irish of some antiquaries; or lastly, from the ancient Celtic, of which the antiquity is determined by its frequent correspondence with the other British dialects originating apparently in this common source at a distant period. A few have also been compounded in more recent times, by adding Gaelic epithets to Danish names. There is reason to think that these names have been successively imposed by the different tribes who in different periods possessed these islands; and, from the predominance of the one or the other, a rude conjecture can be formed of the state of their population during those respective periods. The rarity of names of Scandinavian origin in any given island, thus serves to prove, that few places had been inhabited in the days when it was possessed by this nation; that but a small portion of it was in fact productive, and that the population was consequently low. In the progress of settlement and improvement, new names have been found necessary; and these, being of Gaelic origin, often considerably exceed the Danish in number.* A comparison of the names of places in the several islands, would illustrate the progress of this settlement and improvement; but would lead into details too minute, as well as too conjectural, for the objects of this brief notice. To limit it to the island immediately under review, I may point out as most remarkable, the great number of places which terminate in bust or bus, the remains of the Scandinavian word signifying a place or habitation. Mr. Chalmers appears not only to have overlooked this circumstance, but he has even imagined that these terms were chiefly limited to the exterior chain of islands, which, according to his system, were

* The term Danish, like that of Norwegian, is here, as elsewhere, employed indifferently: the present names, introduced by the Northmen, are found, sometimes in the one, sometimes in the other of these dialects of the Scandinavian.

settled by the Northmen at an earlier period than the interior. As far as his hypothesis rests on this evidence, it is unsupported; while in this particular instance it is decidedly at variance with the geography of Isla; which bears in its names, the marks of Danish settlements in a greater degree than any of the more remote islands, even including Sky.

From these circumstances a probable reason may be assigned for the number and variety of the ancient remains to be seen in Isla; which, although not conspicuous as antiquities, abstractedly considered, are yet remarkable when compared with those found in many of the neighbouring islands.

The monumental stones, whether erected to record battles or covenants, or to mark the sepulture of warriors and chieftains, are numerous, and often conspicuous for their size. Like most remains, they are popularly attributed to the Danes; a prejudice not limited to the Scottish isles, since the memory of these troublesome enemies to Britain, has often assigned them forts and monuments in districts where they appear never to have had establishments. It is superfluous to say that these rude monuments were common to all the descendants of the great Celtic nation. Under one of them, near Kildalton, was found a stone coffin, marking the motive for its erection; but it is unnecessary to point out the several places where they occur; since, however the knowledge of their general existence may be interesting, there is nothing in them, individually considered, to call for particular description.

Connected with these, are the monuments of earth or of stones, which appear in the different shapes of barrows and cairns. Excavations have been made in some of them, and they have been found to contain urns with ashes; the burning of the dead having been at times practised among the Celtic nations, as antiquaries have long since shown.

Among the remains of the earliest inhabitants, may be enumerated those weapons called celts, made of stone

as well as of brass, which have been found in this island; the only instance in which they have been observed in the Western islands, although occurring in various parts both of North and South Britain. These, together with fibulæ of brass, are found in the graves, their usual repositories. That universal weapon of ancient times, to which superstition still attaches some medicinal and antimagical powers in Scotland, has also been met with in this island; namely the elf-shot, or flint arrow head, which occurs also in Sky and in different parts of the mainland. The difficulty of shaping this weapon into the accurate and beautiful forms which it commonly possesses, must have been excessive, and gives a proof of the same patience which is now exerted on similar manufactures by the uncultivated inhabitants of the South Sea islands. If indeed we wish to form a lively conception of the state of ancient manners in our own country, we have only to examine their existing state in those still primitive settlements. History here becomes divested of its obscurity, and of the poetical mist in which it is so often involved by the distance of past ages.

Among the remains of this miscellaneous nature which have been found in Isla, the most remarkable are a number of large gold annuli, amounting to eighteen, which were discovered together in one spot, buried under the soil. They were bent into a circular form, but not closed; and the finder, ignorant of their nature, converted them into handles for a chest of drawers. They are still executing the same office, although their nature and value have been now long known. It is probable that they were the collars of Roman officers, and part of the spoils of war, ("the gold of the stranger,") since the Romans appear to have made no settlements in the Western islands.

Considerable remains of ancient defensive military works are found in Isla; and, as usual, they are erected of laid stone without mortar. They are, like all other similar works, attributed to the Danes; but resemble those which, on good grounds, are proved to have ap-

pertained to the original inhabitants. Antiquaries have certainly discovered no test by which the works of these invaders can be distinguished from those of the natives; the distinctions which have been fabricated appear purely hypothetical. One of the most remarkable and entire of these forts is situated on Lossit hill, and has been a place of considerable importance, though now fast falling to decay. It is of a circular form, and the wall is of considerable thickness; while it is distinguished from most similar works by a step round the interior area at the foot of the wall, resembling the banquette in modern fortification. This is the most common kind of work throughout Scotland, but it is seldom of large dimensions. Sky, as was already seen, possesses numerous examples of them, and they are also found in many places throughout the mainland, as well as in Wales and Cornwall. They vary in magnitude, but are seldom so large as to contain many men. In these circumstances they would appear rather to have been constructed for the purpose of securing the most valuable and defenceless parts of the possessions of these savages, than for containing a garrison; as they could not have given shelter to an effective number, the mode of their construction not admitting of their being defended from within. Besides these works of stone, there may be seen in some parts of the island, remains of earthen works, consisting of an *agger* and a ditch, which have been imagined, but without reason, to be of Roman construction. There is no question but that these also appertain to the same period and people: works of earth ascertained to be British are well known to antiquaries, and among these it is almost superfluous to mention the Brown Caterthun.

Isla affords examples also of a structure, not however of a military nature, which is far from common in Scotland; and which, as far as I know, has not been found in any other of the Western islands. This is the circular mound with ascending steps or terraces; resembling the

well known Tynewald hill of the Isle of Man, and of which the purpose was probably the same here as in that island, namely, that of the seat of justice. This coincidence is to be expected, since the Sudereys to which Isla belonged, formed at one period a common kingdom with Man.

Remains of different strong holds or castles of more modern date are still existing in different parts of the island; the residences of the turbulent chieftains of the Macdonald race. One of the most noted of these is at Loch Guirm, placed on a small island in the lake; a very common mode of natural defence in the Highlands of Scotland, examples of which occur every where. Similar remains, situated in the same manner, are seen at Loch Finlagan; but none of them present any interest to detain either the painter or the antiquary.

Ecclesiastical remains form the last division of the antiquities of this island. It appears to have abounded in these; a natural consequence perhaps of its fertility, as well as of its vicinity to the parental establishment of Oransa. The west side of the country retains characteristic traces of its religious appropriation, in the names of Balinabby, Ardneave, and the island of Neave, or Heaven. In comparing the former with the present state of the Western islands, few circumstances are much more striking than the enormous disproportion of their religious establishments at that period; when also, if we may judge from the poverty of the territory, there could be but few temporal motives for such establishments. If Tirey, from the fertility of its grassy plains, offered such inducements, assuredly the rocky and barren mountains of Harris seem to have held out no great temptations beyond those of a spiritual nature for the erection of twelve churches; while its present population, now perhaps more than doubled, would with difficulty fill one. Many of the chapels in Isla are still tolerably entire, although roofless; and being without ornament, and of small dimensions,

they are in no respect interesting. Two crosses of tolerable sculpture in high relief, although of clumsy proportions, are still entire in the enclosures of the chapel at Kildalton, and similar remains are to be found in other parts of the island. I may add to this enumeration, that the ruins of a vitrified fort are to be seen near the northern extremity of Thurot's bay.

Few lakes, and fewer swampy spots, are found in Isla; the drainage being tolerably perfect, and the small streams by which it is effected, numerous. These rarely unite to form a larger body of water; the only two which can at all pretend to the name of rivers, being the Sorn and the Laggan. To this drainage is in a great measure owing its fertility, and the facility with which, on comparison with most of the northern islands, the rough lands are brought into cultivation. Rivers of so little power will not be expected to have produced much change in the surface; nor can we ascribe to them the alluvia which form so conspicuous a feature in this island; since, in most cases, they are far removed from the influence of these streams. The borders of the Laggan indeed are, towards its exit, formed by high banks of clay and gravel reaching even to twenty feet in altitude; and similar banks are to be traced along the courses of many of the smaller rivers: but a consideration of the general disposition of the great alluvia, will be sufficient to show that these are not the effects of the streams; which have only ploughed their way through the yielding materials they have traversed. The magnitude and depth, as well as the disposition of the alluvia of this island, form one of its most characteristic features; being circumstances by which it is strongly distinguished from most of the Western islands. Jura, Scarba, and Lunga, the continuations of the same rock and the same ridge, are free from such deposits. The alluvia in question are to be found in many places,

but they are most conspicuous on the shores of Loch in daal, which they skirt for a very considerable space. Having here been in former times exposed to the immediate efforts of the sea, they are abruptly cut down, so as to form a series of high banks, attaining, in some places, even sixty feet in height. The effects of this waste, and of other gradual accumulations of gravel and sand, have been such as by degrees to exclude the sea from further access to them; producing the spits of sand which render the entrance to the anchorage of Loch in daal so narrow, and shoaling the water all along the upper parts of the bay so as to have admitted of an obvious encroachment of the land upon the sea. These beds are popularly imagined to have been thrown up by the sea, and to be the remains of ancient beaches; but to disprove this opinion it is sufficient to state, that the alluvia, although consisting in part of rounded gravel, contain perhaps an equal portion either of clay or of vegetable mould mixed throughout their whole mass. They are obviously therefore derived from other causes. Their superficial extent, as well as depth, prevents the possibility of their having been formed by any rivers which could have had their rise in Isla; and we must therefore rest in the general conclusion that they appertain to some unknown period, and to some diluvian action, similar effects of which are to be observed in every part of the globe. It is more remarkable that they should be so generally wanting throughout the Western islands, than that they should be so conspicuous in Isla. But I must observe that, at whatever time they have been deposited, their origin does not appear to be very remote in respect to distance of place; since the pebbles are almost entirely formed of quartz rock, similar to that which constitutes both Jura and the high ridges of this island. Besides these alluvia, there are circumstances visible between Loch Gruinart and Loch in daal, which mark the recess of the sea; but whether at this

period, or at a later one, and from the gradual descent of alluvial matter from the higher lands, is difficult to determine. The whole of this space is a flat peat moss, under which is found a bed of sand and rolled stones with marine shells; rendering it probable, that, at some distant time, Isla was here separated into two parts. The land is still encroaching on Loch Gruinart; the depth of high water being only three feet, and permitting the sea to be excluded by an embankment, with a considerable acquisition of territory.

Besides the alluvia now described, there are found in Isla, in various places, rolled stones of considerable magnitude and of various kinds. Among them are masses of granite, a rock not existing in this chain, and of which no transported fragments have occurred elsewhere among the islands: the remainder are of substances which may possibly be little removed from their natural situations, since they are of trap, quartz rock, and schist. To inquire whence these blocks of granite have been transported, seems useless. Their dissimilarity of mineral character prevents us from referring them to the distant mountains of Arran, of which the relative situation offers sufficient difficulties independent of this. If it be imagined that they have been brought from Cruachan, the nearest mass of granite, little is gained by the conjecture, since the extent and intricacy of the present intervening tracts of sea and land, offer an insuperable barrier to all rational speculation on the changes to which the intermediate space has been subjected. We must be content to repose in the general conviction, that they are of foreign origin, and have been transported to their present places when the forms of the land were far different from what they are now, and before these islands were separated from the mainland. The existence of such masses however, serves to confirm the supposition that the great alluvia already described, and the obvious union of two islands into the

present Isla, have been produced under circumstances far different from any which could have occurred under its existing form and connexions.

In order to render the geological description of Isla more intelligible there is subjoined a general section at right angles to the ridges.* Thus the inclinations of the several rocks will be more visible, and the reader will at the same time be able to trace those alternations which form one of the most interesting circumstances in the geology of the islands of this chain. As the quartz rock constitutes the main body of the collective mass, I shall commence with it, although not the lowermost rock; because the whole can thus be placed in a more luminous and useful point of view.

The general structure of the other islands of this chain already detailed, will serve as a basis for the description of Isla; since the two principal ridges of hills, here called the north-western, and the eastern ridge divisions, are similar to the main ridge of Jura.

Wherever the cross section of these ridges is accessible, the quartz rock is found occupying the same prolonged direction as in Jura and Scarba, and generally dipping to the eastward with corresponding inclinations. In Isla, as in Jura, these vary in different places; the variations being equally remarkable in the former as in the latter island. The variations in the direction appear to lie between the north and the north-east, and the average bearing may be taken as the mean between these, namely, N. N. E. If it be taken still more to the eastward, it will be found more conformable to that which has already been stated as the probable bearing of the strata in the southern parts of Jura. In the same way the horizontal inclination changes from ten to fifty degrees, and in some rare

* Plate XXII. fig. 4.

instances, reaches to seventy; while in one or two, the strata even become horizontal, or incline at length to the westward. But these are anomalies of which a very satisfactory explanation may be seen in this island, as well as in Scarba; the undulations of the strata which cause them, being very remarkable on its eastern side. Among other places, they are very visible at Sanig. But these undulations, and consequent anomalies of inclination, are generally found on the edges of the main ridge, the dip of which is consistently to the eastward. The true average of that dip is not to be assigned, nor is it essential. From this it is apparent, that if the beds of quartz rock which form the leading ridge of the three islands, be considered according to their length, they will be found to undergo a lateral undulation; while the variation in the quantity of inclination at different points, is the result of a second curvature of the plane at right angles to the former. It is only by observations so extended and compared, that the true bearings and connexions of the ancient stratified rocks can be perceived. Limited observations on those subjects are apt to lead to erroneous conclusions.

The general appearance, alternations, and mineral structure of the beds of this rock have been already described so fully, in treating of Jura, that it would be mere repetition to enter into it again, as there is a perfect identity between them in both islands. I may only remark, that at Macarthur's head it contains felspar in considerable proportion, and that it there also contains pyrites. Hence it acquires on weathering a reddish or brown colour; an appearance also very remarkable in Loch Eribol, and at a distance very deceptive, as it is easily mistaken for granite on a superficial view. In this headland, some beds of micaceous schist are also found interposed among the general mass of quartz rock. It was also shown, that on the eastern side of Jura, Lunga, and Scarba, the quartz rock alternates with clay slate and micaceous schist; the main bodies of which lie on that face, and are conse-

quently the uppermost in position. Hence it might have been concluded that the quartz rock was the lowest substance, and that the great mass of Jura was formed of it, while the schists succeeded; an error easily committed by limiting the investigation to that island. The situation of the schists in Isla, shows the fallacy of this supposition; while it presents in an infinitely stronger point of view than the remainder of the chain, the alternations of the quartz rock with these.

The south-western district consists principally of clay slate; but as it is in different places found alternating with thin beds of quartz rock, it is not possible to define its geographical boundary. Different observers would perhaps assign a different one, and perhaps all would be equally wide of the exact truth. Fortunately this uncertainty does not affect the geological inferences to be drawn from the facts; while, in a topographic view, it is of no importance. If an irregular line be drawn from Ardneave to Octofad, it will leave but little quartz rock on the western side; and at some distance from this line, the whole will be found to consist of clay slate; with an important exception, that will be noticed in its proper place. The bearing of this schist is in general conformable to that of the former rock; the irregularities which occur being unimportant, and depending on those partial causes which it is now unnecessary to repeat. Of many places, where both the northern direction and the eastern inclination of the clay slate can be distinctly seen, I shall only point out Sanig, where the appearances are quite satisfactory, and where the position is strictly consonant to that of the leading ridge of Jura and to its prolongations both on the western and eastern sides of Isla. It is difficult even to conjecture the thickness of the collective mass on this side of the island; since the angle of inclination is too irregular to admit of any computation from a comparison of the extent with the visible portions; but assuming that thickness only which

is actually visible in one place, it is not less than 300 feet. This mass then is placed below that which constitutes the two quartz ridges of Isla, and consequently under their continuations in Jura; being thus inferior in position to the whole of that island; where the thickness of the quartz rock is not less than 2000 feet. There is consequently an alternation of masses of these rocks, of mountainous bulk, and in the following order; clay slate, quartz rock, mica slate; since this latter substance lies above the quartz rock in Jura, and, as will immediately be seen, is found in the same situation in Isla.

Two other circumstances occur in the clay slate of this island which are deserving of notice on account of their distinctness, if not of their rarity. The first of these is the alternation of fine graywacké slate with clay slate, in the beds which have been just described as inferior in position to the quartz rock and micaceous schist. The beds of this graywacké are divided at intervals by thinner strata of the clay slate; the first being of a pale greyish colour, and the last of a dark lead blue. These are regularly placed in alternation through a space of an hundred feet or more, and are no less easily distinguished, on a fresh fracture, by their colours and textures, than by the different forces with which they resist the weather; the clay slate being the most durable. There is moreover a natural division in the beds, taking place at irregular intervals, and without regard to the situation of the one or the other substance. They also present a circumstance which, although not uncommon, is seldom so distinctly exhibited, namely, the different positions of the schistose structure and that of the beds. A sketch will render this and the other peculiarities of this schist more intelligible than words.* Independently of the proof

* This sketch, (Plate XXII. fig. 6.) is a drawing of the weathered edge of a bed, the lines nearest the perpendicular representing the furrows formed by the weather in the direction of the fissures. The clay slate escapes the action of the atmosphere, and gives the fallacious appearance of a single

which this rock affords of the repeated alternation of graywacké and clay slate within a very limited space, it is interesting in another way, as presenting a criterion by which in many cases, where no other is attainable, we are enabled to ascertain the position of beds of clay slate, often rendered uncertain by the facility with which the plane of the schistose division may be mistaken for that of the bed.

The second of these circumstances attending the clay slate, is its alternation with gneiss. This was already pointed out in North Uist, but the appearances there are by no means so obvious as in Isla. The gneiss is to be seen skirting the shore from Octofad to the Rinns, and beyond that point. In many places the position of both the rocks is regular, and conformable to the general position of the other strata, while the gneiss is found in large masses, lying either above, or below the schist, or in alternate order. In other cases the clay slate is confused and irregular, and the gneiss also is found irregularly interchanged with it. In no instance was any transition visible between the two, the boundary being strongly marked, and the schist as well characterized as in any other place. As this rock occupies a space of some miles, it cannot be the subject of mistake, either as to its quality or position; nor can it be considered as an anomalous and accidental body. Its composition is peculiar, but has already been noticed in a cursory manner on former occasions, particularly in Iona and in the Long isle. It consists chiefly of felspar, of a red colour, containing distinct aggregations of fine granular hornblende disposed in a scaly manner, or else similar scales of argillaceous schist;

lamina in a different order from the rest; but when the whole bed is forcibly divided, both schists yield together. A similar appearance was pointed out in the sandstone of Strathaird in Sky, and an attempt was made to account for it by the same supposition which is applicable to this, namely, by considering it a modification of the concretionary structure.

and by the position of these, the laminar structure is determined. Whatever quartz may be present, is mixed with the felspar. It is worthy of remark, that where gneiss occurs with argillaceous schist, it generally presents analogous characters; the felspar and quartz being interlaminated at the surfaces of change with the argillaceous ingredient, and towards the more distant parts, with hornblende. Without attention, the two are easily confounded.

This fact is interesting when compared with the analogous transitions, already noticed, which occur between argillaceous and hornblende schist, and which also appear to prevail in the vicinity of gneiss. An analogy equally interesting is presented by a circumstance visible in the neighbourhood of Cruachan. In this place, where the argillaceous schist is traversed by granite veins, it is found to undergo a change of character at the junction, passing into hornblende schist for a limited distance. The fragments which are imbedded in the granite, and which, from their forms and position, appear unquestionably to be detached portions of the same strata, also consist of hornblende; while in certain cases it is even possible to trace the gradual progress from the argillaceous and earthy matter, to the crystallized form and change of substance exhibited in the hornblende. The inferences that may be deduced in all these cases are obvious; and they are strongly confirmed by the analogous circumstances occurring in trap rocks, which are pointed out on different occasions in this work. In these cases the schists are also converted into basalt, or into other varieties of trap of which hornblende is a predominant ingredient; apparently from the influence of those causes which it is unnecessary again to suggest.

The most interesting circumstances relating to the clay slate and quartz rock of Isla having been thus largely dwelt on, in considering the western side of the island, little remains to be said of the same rocks as they are found occupying the eastern ridge. Alternations of a

blueish quartz rock with clay slate are to be observed extending from Isla house to Laggan point, and onwards to the borders of the Mull of Oe; the clay slate between these two latter places being much bent and contorted. As the spaces occupied by these strata will be more easily understood in the Map, it is unnecessary to dwell on them; the rocks, separately considered, present no particular interest. At the headland just mentioned, the alternations are very conspicuous in consequence of the precipices; great contortions being also visible on its western border, with more considerable irregularities of position than in any other part of the island. The quartz rock here occupies the middle place, and the schists are placed on each side. The lateral continuation of these schists forms that part of the island denominated the eastern flat, their position becoming irregular, occasionally even vertical; while they are now and then found alternating with quartz rock, both of the finer kind and of the conglomerated coarse texture. They present different varieties of clay slate and micaceous schist; both these substances occurring, as in Scarba and Jura, in an order so irregular that it is impossible to distinguish them in description.

I have in this detail purposely omitted some of the schistose rocks, which occur among those already described, just as they have been shown to do in Jura; on account of the small spaces which they occupy and the impossibility of pointing out, either in description or in the Map, the places where they are situated. These are, varieties of chlorite schist, of talc schist, and of hornblende schist. It is not unusual to find these substances occurring in beds of micaceous schist elsewhere; a transition from the latter to one or other of the former, frequently accompanying the change. Similar transitions also happen between the same substances and clay slate, of which numerous examples occur on the southern border of the Highlands throughout the whole line. They present no particular appearances in Isla deserving of attention,

and will be described more properly hereafter in situations where they are more conspicuous and important.

The strata thus described as extending from the western side of the island to the Mull of Oe on the east, can be traced in contact and in obvious succession throughout this whole space. It will not therefore be useless to review the whole alternation before proceeding to the description of the remaining rocks which occupy more limited spaces. Omitting the minor repetitions, it is as follows: clay slate, gneiss, clay slate, graywacké slate, clay slate, quartz rock, coarse graywacké, quartz rock, clay slate, micaceous schist, clay slate.

It is now necessary to describe those rocks which are more obscure in their structure and position. The causes of that obscurity will be found to depend on the place they occupy in the island, on the nature of their disposition, on the forms of the surface, and on its encumbered state. The most remarkable of them do not reach the sea shore so as to display their sections, nor is it possible to obtain a continuous view of any portion of them. By the aid of analogy they may perhaps be referred to their true geological positions.

The principal, and the most extensive of these rocks is the limestone, which chiefly occupies the middle division of the island. Its general extent will be seen in the map better than it could be understood in description, but an accurate limitation of that space is impossible, on account of the depth and fertility of the soil. There are three kinds of this limestone, and such is the nature of their several characters and connexions, that each requires a separate consideration.

The first and most extensive is the blue schistose variety, which forms perhaps nine tenths of the whole. Both the geological and mineral characters of this rock are familiar to all those who are acquainted with the Scottish Highlands; as it is of frequent occurrence, and is found, among other places, in Lismore. It occupies an irregular

surface marked by the frequent protrusion of rugged hills, ridges, and single rocks; in which every possible variety of direction and inclination, from the vertical to the horizontal, and from the straight to the curved, may be seen in some place or other; since however irregular these detached rocks are, they appear all to be portions of one stratified mass. It is every where interfoliated with fine clay slate in different proportions; the slate predominating in many places to the exclusion of the limestone, while in others again the reverse takes place. But whether the slate be present or absent, it has a schistose fracture, although that is generally the result of some almost imperceptible lamina of clay slate by which it is accompanied. The alternations of the two substances are often so frequent and so delicate, that a specimen cannot be distinguished from clay slate when examined on its surface or leading fracture; while, when viewed on the cross fracture, the limestone alone is seen, and the schist disappears. These alternations are generally found at the junction of a considerable mass of the one rock with the other. The limestone is invariably lead blue, although sometimes traversed by white veins, and is commonly of a fine grain; the clay slate being of the same colour, and often silky and undulated on the surface.

In addition to the topography of this variety of limestone as it is detailed in the map, a few remarks are necessary. The principal mass seems to lie in an irregular manner, since it is wide in the middle and becomes contracted near the northern shore; while it also appears to terminate near the farm of Lossit before it reaches the sea. Considering the high angle which the strata occupy, it may be conceived that this part is the extenuated edge of the deposit, and that if the strata were here as high above the sea as they are in the interior, they would preserve a corresponding breadth. Though presenting the superficial form of those secondary strata which occupy basin-like cavities among the primary, it

is obvious that they are placed in parallel alternating order with these.

A smaller tract of the same limestone is found near the Duich river. In some places the alluvial soil prevents this from being traced to the former more extensive mass; while, in others, it is obvious that the quartz rock intervenes so as in some measure to prevent the one from being prolonged, according to the bearings of the strata, to the other. It must probably be considered as a distinct portion, occupying a series of beds forming a double wedge; since it cannot be traced to the southward, where, if it existed, it must appear on the sea shore. Similar masses are so common where limestone occurs among the primary strata, that the present instance can excite no surprise.

The last portion of this limestone occurring in Isla is found on the shore about a mile to the westward of Ardmore point. This is in a vertical position, and alternates with very thin beds of clay slate, like the two former. The prolongation of the strata does not permit it to be considered as part of the mass last mentioned; and it must therefore be supposed a similarly independent portion.

The next limestone is in very small quantity, and bears the same relation to micaceous schist, as that last described does to clay slate. The same description, with the requisite alterations, will therefore serve for both, except that the colour of this is grey or whitish. The geological connexions are as obscure as those of the former, and I may add, that I only observed it in the neighbourhood of Portaskeg.

The third is of a different character, and although it does not appear to occupy a great extent, its connexions are to a certain degree apparent and its history comparatively satisfactory. It is most easily seen in Lossit hill, forming beds of considerable thickness, and alternating with the quartz rock; the ordinary inclination of

which it follows. This limestone is exceedingly compact and of a fine grain, like the primary limestones of many parts of Scotland. It is not interlaminated with the quartz rock, as those which lie in the schists are with their accompanying rocks, but is often highly siliceous in composition, and much indurated at the points of contact with that substance. It varies from a greyish to an ochrey white. These are the only limestones which I observed in their places, and I am unable to give any more satisfactory account of their connexions than that which may be drawn from the above statements. Loose specimens of another limestone remarkable for its cavernous granular texture are here found on the surface, but whether only an accidental substance, or portions of some bed, there were no means of knowing.

The next rock remaining undescribed is a conglomerate of a remarkable texture. The most accessible points of observation are at Portaskeg, and at Lossit hill. The rock at Portaskeg extends along the shore from Ardnahu bay to within half a mile of the farm of Lossit, and may also be traced inland; but its relation to the limestone is obscured in the interior by the soil, while, on the sea shore, as was just shown, that rock does not occur. It is in contact with the quartz of Ru vail on one side, and is succeeded, at the short interval just noticed, by that of Macarthur's head. In external general appearance, natural fracture, and the position of its masses, it resembles micaceous schist so exactly that it might readily be passed over as an ordinary bed of this rock alternating with the quartz rock. In position it corresponds with that rock on each side, the elevation of that which forms Macarthur's head being about 45° and, on the other boundary, not very different. In respect to composition it is a micaceous schist, containing imbedded fragments of granite and quartz rock of variable magnitude; and it may with propriety be called a primary conglomerate.

The conglomerate at Lossit hill possesses a more decided character. It is found distinctly placed above the white limestone just described, and in many places in contact with it; forming a considerable, and apparently a single bed. This bed has that air of antiquity which characterizes the older rocks, having an appearance of distinct stratification, but being at the same time divided vertically into irregular prismatic forms, resembling at a distance, some kinds of granite. Its basis is a coarse schist, and it splits naturally into thick schistose laminæ. It contains fragments, scarcely rounded, of granite, and of the white limestone on which it lies; these varying in dimensions from a tenth of an inch to that of several inches. By this last character, as well as by its position, its posteriority to the limestone is determined. It is probably a portion of the conglomerate described before, the variation depending merely on the character of the subjacent rock; a conjecture strengthened by a circumstance that will be immediately mentioned. The character and position of the conglomerates of this description, bespeak an antiquity commensurate with that of the schists which they accompany. They are rare, as far as I have observed, in Scotland; but besides that described in Garveloch, and that occurring in Schihallien, they are found in the hills which extend from this mountain to Ben vualach; as well as at the source of the Spey. There is nothing however in this appearance inconsistent with general facts, but there is rather, on the contrary, ground for surprise, that such rocks do not more commonly occur; since the several schists which they accompany have been formed from fragments of the same rocks more comminuted. Analogous conglomerates seem to be most common in the quartz rock, as will appear from the preceding descriptions of Jura, Scarba and Lunga; and they are found alternating with the strata of finer texture that are composed of the same materials. The reason of this will perhaps

be found in the superior hardness and durability of this substance; thus rendering it more capable of resisting the actions by which these fragments were produced.

In attempting to elucidate the history of these limestones and that of the accompanying conglomerates, by the analogous observations to which I alluded, light will be thrown not only on the different points here brought into comparison, but a very interesting community of strata, will be indicated; although perhaps actually interrupted and again renewed, as is not unusual among the primary strata.*

In the preceding remarks it has been shown, that the extreme limits of the lines of direction in the strata of the schistose islands already described, lay between N. ½ E. and N. E. by N.; and in the first group it was further shown, that all the strata were regulated by the one or the other of these bearings. The directions in Jura and Isla have not been ascertained with the same accuracy, yet they have still been found included within the above named limits. It has also been remarked that the apparent point of flexure in the strata of Jura, took place near its northern extremity, where it is indicated by the outlines of the coast; the northernmost portions of that island lying on the N. ½ E. rhumb line, while the southern, even to the extremity of Isla, tended considerably more to the eastward. If from Lossit hill a line be drawn to Garveloch conformable to these directions, a correspondence will be found to exist between the bearings of the strata in these two remote places, as accurate as could be expected from the nature of the maps and the known deviations to which such strata are liable. This coincidence is very remarkable, and appears in itself almost demonstrative of the identity of the beds of Garveloch with those of Lossit hill. But a stronger proof of it seems to be afforded by the simi-

* See the general Map.

larity of the substances in both, and by the correspondence in their positions and in the order of their succession; while the rarity of the substances in question, which are no where else to be seen in these islands, tends still further to confirm this view. It is not however necessary, as already suggested, to imagine that they are absolutely continuous and of the same dimensions throughout; the well known attenuations to which strata are subject, may here exist without materially disturbing the general conclusion now drawn. The strata of Lossit hill will thus assume their regular situation in the series which forms Isla; and will be found to alternate, according to the order of succession already established, with those rocks that possess the greatest degree of regularity; being bounded on both sides by the various alternations of the schists and quartz rock already described. Thus also the geological structure of this chain of islands may in a great measure be completed; since it is probable that the schistose strata, which form the mass of Isla to the eastward, are prolonged under the usual variations arising from alternate dilatation and extenuation till they meet with the intruding trap of Mull. Garveloch will thus also appear no longer an independent and anomalous mass, but part of a regular series; remaining insulated in the sea, a beacon to indicate the system of order which pervades the whole.

A similar analogy may be extended to the blue limestone first mentioned, by comparing it with that of Lismore, an island which will shortly be described.* The general bearing of that island and of its strata, will be shown to be nearly parallel to that of the northern portion of Luing, and to those of Garveloch and Seil, namely, N. E. by N. or somewhat more easterly. It is not possible however to establish here even the same limited appearance of continuity as in the former instance; since that is

* See the general Map.

prevented by the peculiar form of the limestone mass of Isla, and the prolongations of the strata do not admit of the same adaptation. Neither could it be expected; since the two points are so far asunder that the obliteration and renewal of the calcareous strata may occur in the interval, and many derangements of the line of bearing may also take place, which from the nature of the adjoining country do not admit of examination. Yet it must be remarked, that as the bearing of the strata in Kerrera, as far as they can be ascertained, and the general outline of that island, are more northerly than in Seil, it is probable that the strata of Lismore undergo a flexure in a line parallel to the latter island, which, with the others to which they are subjected in their course to Isla, will bring them within the limits required for establishing the species of continuity in question. The rocks in both islands are identical in character and composition; and, together with the circumstances now pointed out and those which have preceded, will, even if judged insufficient to prove the identity of these strata, serve to illustrate the connexion of the blue limestone of Isla with the approximate schists. Thus, like that lately discussed, it will find its place among the general series of these schistose rocks; while the irregularities that accompany it may possibly hereafter disappear, or at least be materially diminished when it shall be examined by some future geologist with the clue here afforded. My own examination of Isla having preceded that of all the other Schistose islands, was deprived of this assistance: had they been examined in the order in which they have been described, many of the difficulties which were encountered would not have occurred.

The last rock which remains to be noticed, is that anomalous rock of porphyritic aspect already mentioned in the account of Jura; and of which considerable masses are to be seen in the neighbourhood of Kildalton on the eastern shore. This forms a range of craggy eminences,

scarcely deserving the name of hills, lying on the outer parts of the slate, and in a direction corresponding to that of its beds. It is very irregular in aspect and form, being split into fragments similar to those of the schist which it accompanies; and it might for that reason be readily overlooked. The basis of this rock is a blueish indurated clay, very much like the schist with which it is associated, and the crystals of felspar, of a pink colour, are very crowded, and generally about the size of a small pea. The resemblance of this substance however to the porphyries is quite superficial, since the masses, notwithstanding their appearance of independence, are portions of beds appertaining to the schistose rocks.

Having thus terminated the account of the principal rocks which enter into the composition of Isla, it only remains to describe the veins, and the independent minerals.

The most numerous and conspicuous veins are those of trap, which are found throughout the island, but are particularly abundant on the shore between Balachar and Macarthur's head, and between Ardtala and Ardmore. Their courses are continuous for a great space, and may often be traced almost across the whole country. The remarks however already made in describing those of Jura, supersede the necessity of dwelling on them here: a few particulars will suffice. Their direction is various, and their breadth varies from forty or fifty feet to ten. In general they are more permanent than the surrounding rocks; in consequence of which they are traced by their protrusion, and not, as in many other places, by the cavities which they have left. The permanence of these veins has here in many cases, as well as in Jura and in Mull, produced very remarkable appearances; the high walls of trap remaining in the form of ruined castles or buildings. The quality of the veins varies, but the most prevalent is a black basalt. This is often amygdaloidal, containing zeolites; in a few instances it passes into greenstone, and

in some places is found splitting into thin laminæ like common slate. Near Kildalton there is one very large vein which must be ranked with these, although, in structure, it could not be distinguished from a syenitic granite; not the only instance in which the mineralogical boundaries of these and of the trap rocks are difficult to define.

Quartz veins also occur in this island; a feature too common to be worthy of notice were not some of them attended by a remarkable circumstance, namely, an intermixture of brilliant oxidulous iron in thin reticulating laminæ and in great quantity. A very conspicuous example of this nature occurs near Portaskeg.

There is yet a circumstance in Isla connected with the consideration of veins, which it is necessary to notice, because it seems to have led to erroneous conclusions. This is the supposed existence of veins of clay slate, an appearance equally common in Scarba and Jura, and indeed not very rare. These supposed veins are always contorted and irregular, while they are also interrupted by veins and fragments of quartz.* They are either bounded by quartz rock, or by other materials; in these islands the walls are of the former substance. When they are carefully examined and their continuations are traced, it will be found that they are portions of beds which have undergone the contortion and elongation so frequent in micaceous schist and gneiss, and are thus drawn out into forms slightly resembling real veins. Some of the contortions of gneiss which occur in the Long island are precisely of the same character, and derived from similar causes. The deception, if such it may be called, produced by these contorted and elongated portions of stratified rock, is occasionally such, that it requires some attention to avoid being misled by them. In describing the hill of Kinnoul, on a former occasion, some remarkable examples of these appearances

* Plate XXII. fig. 5.

were given, tending materially to illustrate this view.* Every phenomenon of this nature points to some former condition in the state of these rocks, under which they were at times so hard as not to be displaced without fracture, at others so soft and yielding as to admit, not only of simple flexures, but of very complicated contortion and elongation. It is not difficult to imagine, that in this latter state, an extension of the same mechanical force which produced simple elongation, might under peculiar circumstances draw out the softened mass into the ramifying disposition which has led to the notion that such rocks formed genuine veins. It is plain that they afford no arguments against the posteriority of real veins, whether of trap or of granite, to the stratified substances which these traverse; since the cases bear no resemblance in reality, whatever they may do in external and superficial aspect.

The only independent earthy mineral which I observed in Isla was chlorite, and, as is most commonly the case, it is imbedded in quartz: the metallic minerals are of greater variety and importance.

The most conspicuous of these is lead, which has been wrought at no very distant period, as well as in ancient times, but is now abandoned. In consequence of the absence of the last lessees of this mine, and the death of the manager, no information respecting the workings, or the nature of the veins in which the ore was found, could be procured. Nothing can be discovered from the present state of the shafts and levels, or from the casual pieces of ore or veinstones which are found scattered about the abandoned works. It can only be ascertained, that the ore consists of galena intermixed with copper pyrites, and that it lies in the limestone

* Geol. Trans. Vol. IV.

in the neighbourhood of Portaskeg, which belongs, as must already have been apparent, to the primary class of rocks. It has been wrought in five different places, but there are no means of discovering whether these were distinct veins. It is indeed said in the island, that there were no continuous veins, but that the ore was found in independent masses: the authority for this assertion is not however scientific. There would be great facility in renewing the works, as the bottoms are in a state of drainage by means of the levels; the position of the ground being favourable to the discharge of water.

Iron is found in various forms in different parts of the island. In the white limestone of Lossit hill there is a considerable bed of brown hematite interspersed with minute crystals of oxidulous iron, of which some has been sold and exported. This ore is sometimes magnetical, and it has been said to produce good iron. It was already mentioned that oxidulous iron ore is here found in quartz veins, and it occurs besides in many other situations, chiefly in the clay slate; but in quantities far too small to render it an object of economical pursuit. Bog iron ore may also be seen in several places under the peat; the country abounding in chalybeate springs, from which it appears to be a deposit. A sort of siliceous iron stone is not unfrequent among the alluvial beds; being fragile, and apparently of very recent formation.

Such were the minerals that came under my own observation, but I was informed that common reniform iron stone had been observed in some places. No specimens of this ore were however produced, nor can I understand whence it could have been derived, as it is not a substance to be expected in any of the rocks which have been described. The workmen in the quarries further assert that they sometimes pick up that variety which is characterized by the loose position and mobility of a central nodule. It is further said,

that manganese has been found, but no one could point out the place or produce a specimen, so that this remains as yet a problem to be solved. The most remarkable of the metals said to have been discovered here is quicksilver, which was found in a peat moss on the western face of the eastern ridge; the quantity collected having been two quarts by measure. This occurrence took place upwards of forty years ago: none has ever been observed since that period, nor has any conjecture been formed of the source whence it was derived. It is further said, that native sulphur has been seen in the limestone; but neither could I see specimens of this, nor procure any satisfactory information respecting it. The existence of cobalt and of emery, both described by mere reporters of the questionable evidence of others, seems more than doubtful. With respect to all these minerals it is proper to remark, that a general notion pervaded the Highland proprietors, at a period well remembered in Scotland, of the extent and value of their subterranean treasures. Of the speculations suggested by persons, often more interested in the research than in the discovery, the mine of Strontian has been almost the only one that has justified the views of the reporters. It is not unlikely that the reports respecting the metallic minerals of Isla, which are of the same date, owe their origin to views equally visionary, sometimes perhaps, fraudulent.

Some of the clay slate has been quarried for roofing, but it is neither good nor very abundant. It affords however large flags of great utility; and similar slabs of the quartz rock, adapted to the purposes of paving, are raised for trifling uses in rural economy.

It has been imagined that coal existed in Isla, and some searches have been instituted in pursuit of it; without judgment, but possibly not without dishonest views, since the excavations appear to have been made in quartz rock and clay slate. There are no traces of secondary strata throughout the island.

COLONSAY, AND ORANSAY.*

It is unnecessary to separate these two islands in description, as their geographical connexion is not less intimate than their physical structure is identical. They form, in fact, but two parts of one chain of hills, which, by their general bearing and conformity to the Schistose islands, and more particularly to the western parts of Isla, may be considered as portions of the same set of strata, the intermediate parts being concealed by the intervening sea. They are extremely uninteresting in a geological view, and might, but for their topographical claims, have passed unnoticed.

They are situated about nine miles to the northward of Isla, but somewhat westerly; the collective length of the two being about twelve miles, of which Colonsay occupies nearly ten. The strait by which they are separated is nearly a mile broad, and becomes dry at low water.

Colonsay is a hilly island, about three miles in breadth where widest, and presenting on each side, when viewed from the sea, an aspect of rudeness, which in a great measure disappears on crossing either of the ridges that skirt the shore at its northern end. A valley containing a fresh water lake is here found, extending for a considerable space in the direction of the length of the island, which is distinguished for the excellence of its pastoral and agricultural system. The elevations of the hills do not appear to exceed seven or eight hundred feet, nor are they characterized by any peculiarity of feature. The natives point out caves in the cliffs, which on examination prove to be mere

* From Saints in the Gaëlic Calendar, and, like all the rest, of Irish origin. See the Map of Isla and Jura.

fissures resulting from the dislocation of the schistose rocks of which they are composed. Considerable banks of shell sand are thrown up in various places along the western sides of both islands: in Oransay this substance forms a large portion of the surface.

Some small remains of a monumental and religious nature are to be seen in Colonsay; but Oransay still presents one of the most entire and extensive ruins of the ancient monastic establishments of the Western isles. As a very ample account of these relics has been given by Pennant, it is unnecessary to take further notice of them.

The predominant rock of these islands is micaceous schist, often approximating to chlorite schist and to clay slate, and presenting a smooth and glossy surface. It is generally attended with numerous and conspicuous contortions. Some varieties of a quartzose micaceous schist, and of quartz rock, also occur; but as there is nothing to be found here which has not already been, perhaps more than sufficiently described, I shall forbear to enumerate these uninteresting particulars. It is only necessary to remark, that at the farm of Ballyremondhu, in Colonsay, a thin bed of limestone is found interposed in the usual manner among the schist. The relation of these islands to those which lie to the eastward, will be readily deduced hereafter from the general remarks on the structure of the Schistose isles that will conclude the account of this division.

LISMORE.*

THIS island is situated in the bay of Oban, at the mouth of the Linnhe Loch, being about eight miles in length, and seldom exceeding one in breadth; thus forming a long narrow ridge. Its surface is uneven and beset with abrupt projecting rocks; which being sometimes covered with verdure, put on the appearance of small hills interrupting the general level. These rocks and stony hillocks are in many places so abundant as to prevent the use of the plough, thus condemning to pasturage many tracts of the most fertile land which the western coast affords.† This fertility arises from the nature of its soil, the rocks which form the island being almost entirely calcareous.

Lismore presents but little to amuse or interest the general traveller. The forms of the ground are not picturesque, while the total absence of wood gives it that air of bleakness and sterility which, to the painter's eye, is never compensated by flowery meadows or fertile fields. The cliffs are too low and too little varied to admit of those combinations of maritime scenery which are sufficiently common throughout the Western islands to render the absence of other modifications of picturesque beauty less perceptible. If however it is deficient in this respect, it presents to the artist a station whence he may survey the almost unexampled magnificence of the bay of Oban, and the ranges of mountains which bound it on all sides. To the eastward, the summits of Cruachan and the hills of Appin, extend in a continued and intricate chain to Ben Nevis, while the rugged and brown land of Morven constitutes the boundary to the north; the mountains

* See the general Map.

† Hence its name; Lios more, the great garden.

of Mull retiring in distant perspective to the westward, succeeded by the high and bold mass of Scarba, and the fainter tints of the cones of Jura. Rocks and islands which cannot be counted, checquer the magnificent extent of sea included in this circle; which is enlivened by the perpetual appearance of ships entering the bay, or navigating the Linnhe Loch and the sound of Mull. The historical interest excited by the castles of Duart, Dunnolly, Dunstaffnage, and others which are visible from this station, complete a scene which has not a parallel in the whole range of this variegated and picturesque coast. Though the geologist will find little to reward him, in his particular pursuit, he will not regret a summer's day spent on the wild thyme and the grey rocks of Lismore.*

The population of this island is proportioned to its fertility: even in ancient times it was celebrated for both. Hence, a number of ecclesiastical and castellated remains are to be seen, far too insignificant at present to require

* At the western extremity of this island are some rocks separated at low water, where the cattle may be daily observed resorting; quitting the fertile pastures to feed on sea weed. It has erroneously been supposed that this practice, as well as the eating of fish, was the result of hunger. It appears, on the contrary, to be the effect of choice, in cattle as well as in sheep that have once found access to this diet. The accuracy with which they attend to the diurnal variations of the tide is very remarkable; calculating the times of the ebb with such nicety that they are seldom mistaken even when they have some miles to walk to the beach. In the same way they always secure their retreat from these chosen spots in such a manner as never to be surprised and drowned by the returning tide. With respect to fish, it is equally certain that they often prefer it to their best pastures. It is not less remarkable that the horses of Shetland eat fish from choice, and that the dogs brought up on these shores continue to prefer it to all other diet, even after a long absence. The feeding of cattle with fish is a practice well known in Canada, and it is recorded on the authority of Herodotus that the inhabitants of the lake Prasias fed their horses and cattle on fish. This fact offers to physiologists a singular example of the accommodating powers of the stomach of these animals, and of the convertibility of their natural instincts.

particular notice. It is now the seat of the Roman Catholic College, an establishment maintained in great part by the produce of the lime quarries; large quantities of this commodity being here burnt, and exported for the consumption of the whole western coast.

The fertility of Lismore in grain, renders it a centre of illicit distillation, for which the facilities are also greatly increased by its extent of sea coast, and the consequent ease with which the manufactured commodity can be exported; while the vicinity and population of all the surrounding shores, offer a ready market for the sale of the produce. The process in all its stages is here, as elsewhere, extremely simple; the necessity of concealment with the risk of seizure, added to the limited capitals of those who carry on the trade, restricting the apparatus to a very small size. Two or three tubs for the wash, as many casks for the produce, and a common still, of about eighteen gallons capacity, with a very short worm, form the whole establishment, and even this is generally divided among many adventurers. Occasionally a rude and open hut is erected to shelter the materials and protect the operators from the weather: this however is often dispensed with, and the process is conducted in the open air under the side of some hill or rock, which, while it affords concealment and shelter, admits the ready introduction of a running stream from above into the worm tub. In insular situations, or on the sea coast, the shore is generally chosen, since it not only enables the operators to keep watch against the visits of revenue boats, but facilitates the concealment of their commodities in case of an attack; thus enabling them to escape the terrific summons, which is frequently a sufficient punishment, since it may compel the delinquents to a distant attendance, exceeding in expense and inconvenience the amount of the penalty.

In an agricultural view, the question respecting distil-

lation from native grain is here of considerable importance; since the destination of a great portion of the barley grown in the Highlands is to this object. It is unnecessary to enter on the question so often examined, relative to the general policy of distillation from grain; it is perhaps too popular a subject to admit of being always discussed with that freedom from prejudices which all economical questions require.* It is certain that the present scale of Highland rents, in many places, could not subsist without it; since the price of grain would in such districts fall to a rate which would render its production impossible, and a great portion of the land now in cultivation would be eventually thrown into pasture. It is obvious that it is thus the interest of the proprietors to permit at least, if not to countenance distillation; and unless where a profligate conduct in the distiller, leading to a neglect of his particular farm, produces occasional loss to the land owner, he is a gainer by the illicit trade in consequence of the increased produce of his land and the superior price of that produce. A stronger instance of this can scarcely be given than that which occurred in Isla in 1815, when barley was at double the price which it bore in the Lothians, although the crop was abundant. The new regulations recently adopted respecting the licensing of small stills in the Highlands, will now, it is probable, remove all causes of complaint; by giving the Highland proprietor, like his neighbour of the low country, a fair price for his grain, or that price at least to

* That it offers an important resource in cases of deficient crops, has been effectually argued. A decided practical proof of this occurred here in the year 1813, well remembered for its scarcity, and for the restrictions on distillation by which that was accompanied. In that year scarcely any whiskey was to be procured in the islands; many were entirely destitute. On asking the reason of a native in Jura, he stated the scarcity of oatmeal as the cause; "We must now make all our bear into bannocks," was the answer: no stronger illustration of the practical convertibility of spirits into food could have been offered.

which he has been accustomed; while the manufacture will have the sanction of law.*

The description already given of the limestone of Isla, will have prepared the reader for the geological history of Lismore.

The whole island consists of a series of calcareous strata extending more or less accurately, according to the lines of the coasts, from one extremity to the other, and consequently in a general north-easterly direction. That direction is however rarely maintained long in any one spot, being subject to frequent deviations, from the apparently disturbed and broken state of the beds. The same apparent confusion attends the dip, which although in a general sense toward the east, like that of the Slate isles and the neighbouring gneiss of Morven, is exceedingly irregular in the smaller parts, the strata being frequently found in an erect position, and occasionally, even reversed. In this respect the rock of Lismore bears a striking resemblance to the corresponding limestone of Isla, the irregularity of which is such as there also in a great measure to prevent the determination of its dip or bearing. In addition to these irregularities, the beds are frequently bent or contorted, often to as great a degree as the micaceous schist of the central Highlands. The characters of the rock correspond so minutely with those of the blue limestone of that island, already described, that further mention of them is unnecessary. It may only be remarked, that

* Notwithstanding a popular opinion to the contrary, it may truly be said of the Highlanders, that they are no less sober than generally correct and exemplary in their moral conduct. Whiskey is in fact so rare and expensive an article, that it seldom enters into the Highlander's cottage; and although where great gains are occasionally made, instances of systematic drunkenness may be found here, as well as in manufacturing towns, the generality of the population is as much excluded from the frequent use of whiskey as from that of Tokay. The interior consumption has been gradually reduced to perhaps a twentieth part of what it was some years ago, and the habit has nearly ceased as the difficulty of procuring the article has increased.

the clay slate, which is here interlaminated with the strata, occasionally predominates for a small space so as nearly to exclude the limestone. It is perhaps unnecessary to add that it is a primary rock.

Natural caverns occur among these beds in different places; of no great extent, but generally containing large and ancient stalactitic concretions, the further increase of which seems long since to have ceased. In the interior, they much resemble the similar concretions of Gibraltar and of Sicily, which have been so often wrought for purposes of ornament.

The rocks are much traversed by veins of calcareous spar, of quartz, and of these two substances united. These veins are commonly small, frequently very minute, and a certain class of them follow the contortions of the rock in which they lie. The whole question relating to contortions is so obscure, that it does not materially add to the difficulty to imagine that the veins of quartz had undergone this process conjointly with the rock in which they are situated; although we have at present no conception of the mode in which quartz could be softened so as to undergo this change. The phenomenon is however by no means uncommon, since it occurs also in the parallel granite veins that traverse gneiss.

It is evident that in these cases, the quartz, whether in the shape of a vein or a lamina, must have been formed by deposition, or by secession of the containing parts and subsequent infiltration, while the rock was in its straight or natural form; since the intricate examples in question could not have been produced by either process in their present state. It necessarily follows that the contained vein was bent when the including rock underwent the change; and indeed the mutual relation which these bear to each other is sufficient to prove that the same cause operated simultaneously on both. That we cannot explain the process is no argument against the supposition; since it is but one of numerous instances where we must

continue to believe in hopes of a future solution of the difficulties.

Trap veins abound in Lismore, as might be expected from the vicinity of Mull. They seem to present no appearances that have not been sufficiently described on other occasions.

THE CRAIGNISH ISLES.*

UNDER this general title is included a number of islands exceeding twenty, some of which lie within the Loch of Craignish, and the remainder occupy various positions on different sides of the point which bears the same name.

The principal islands in the loch are, I. Mackalken, I. Macrean, and I. Ree; and the most remarkable on the outside are, I. Macfaden, Rusantrue, Resave, Garvrisa, and Baisker; each group being accompanied by many smaller islets and rocks, of which the names, if they have any, are only known to the few fishermen who live in the immediate vicinity. Island Ree and Macalken island are the largest, being each about three miles in length and half a mile in breadth: I. Macrean is considerably less; and of the rest, Garvrisa, which is the largest, is scarcely a quarter of a mile in its greatest dimensions. The smaller diminish gradually to mere rocks; all of them however bearing grassy summits, and being, in the breeding season, the resort of the Tern, which approximates to itself all the untenanted green rocks of this coast.

The islands within the loch are highly picturesque, being covered with patches of coppice and interspersed with fine trees; the disposition of which is rendered very ornamental by the intermixture of houses, grey rocks, and irregular ground. They all bear the marks of having been once entirely covered with an oak forest, many remains of very large trees still existing in various

* The uniform composition of these islands renders a geological map of them unnecessary, while their size is such that they can scarcely be distinguished in the general Map belonging to this work. Those who wish to acquire a more accurate knowledge of the west coast, and of the minute parts of its geography more especially, must consult Arrowsmith's large map.

places. Such solitary trees are also found on the small islets in the outer division, under circumstances in which heath will scarcely now attain to its full growth. It is not easy to comprehend how they ever grew in these spots, of which the extent is so small as to have been incapable of affording the shelter that is produced by the successive growth of wood. Even in the most exposed situations, where there is room enough, it is easy to understand how the gradual increase in size of the windward trees, through a long period of time, enabled the leeward parts of a forest to attain the size now visible in the remains of these ancient woods; without imagining any change of climate, or any other difference than that of the relative proportions of the population in ancient and in modern times.

These islands, like all the wooded inlets of the western coast, abound with thrushes, the melody of which produces a very singular effect when contrasted with the maritime objects at hand, and with the notes of the sea fowl. As the anchorages are in many places close to the shore, the voyager who has unknowingly entered them at night, and who is perhaps dreaming of storms and shipwrecks, is often awaked in the morning by the well known sounds of rural life, and surprised to see the trees above his head; while the heaving of the anchor and the hoisting of the mainsail, mixed with the warbling of birds and the lowing of cattle, make him imagine that he is still but dreaming of the objects more congenial to his feelings.

The principal group of the islands within the loch, extends in a prolonged direction for eight miles in length, presenting a line of perspective of which the effect is exceedingly striking. A succession of wooded hills and rocks is seen retiring from the eye to a distance that appears indefinite, with a perpetual repetition of similar parts in gradual diminution till they vanish in the air tint of the distant hills; the effect being rendered still

more impressive by the parallel sides of the loch, which accompany them with a similarity of character and disposition.

Between Garvrisa and the point of Craignish is the passage known by the name of Dorish more, (the great gate), frequented by vessels passing from Crinan northwards, and distinguished, like the other narrow channels of this coast, by the strength and rapidity of the tides and by the short cross sea produced when their course is opposed to a fresh breeze.*

Notwithstanding the geographical insignificance of these islands, their geological history is important, as they will be found to appertain to an extensive series of rocks, already noticed, which forms a considerable tract in Nether Lorn, Knapdale, and Cantyre. Shuna, formerly described, is a portion of this series; and it will hereafter be seen to extend to the isles of St. Cormac, and to the associated islands of Gigha and Cara.

As all the Craignish isles are similar in composition, the same general description will suffice for the whole: the more extensive connexions and general relations of the series will be best understood when the remaining islands of similar structure have been described.

The leading direction of the strata appears to be north-

* On the day of my visit to these islands, a boat with six men was lost in this passage; an accident, like most of those which happen in the Western islands, resulting from the rashness and ignorance of the boatmen. Were it not for the extreme buoyancy of their boats, generally built on the plan of a Norway skiff, and often indeed built in Norway, such accidents would be more frequent, as no experience seems to have taught them the management of a boat in those delicate cases which are of perpetual occurrence in such a sea of cross tides and in a climate so squally.

It is not an exaggeration to say that the traveller who makes this tour, is in daily, often in hourly risk of his life, more particularly with the boatmen of the country; the rigging of their boats being as bad as their management. Fortunately for themselves, their timidity is generally equal to their ignorance.

north-east. In this respect they correspond with those of the various islands included in this division, as nearly as could be expected from the remarks already made on the lateral deviations of these lines of bearing in the several portions of this extensive group. They present a similar correspondence with the strata of the adjoining mainland, as their leading outlines do with those of the various headlands and inlets to which they approximate in position. The dip of the strata is to the eastward, in which respect they resemble the Slate isles, as well as that part of the mainland with which they are geologically continuous. The angles of inclination are various, but rarely exceed 40°, while, in a few instances, they approach much more nearly to the horizontal position.

The description of the rocks of Shuna already given, corresponds so nearly with that of the Craignish isles in the most essential points, as to supersede the necessity of any minuteness in enumerating those which here prevail: these details, like the history of their connexions, will be better reserved till all the associated islands have been described. The principal rocks are quartz rock of various characters, micaceous schist, and chlorite schist under several distinct modifications.* Of these, the latter is the predominant, occupying perhaps three fourths of the whole space, the quartz rock bearing the next proportion, and the micaceous schist scarcely amounting to one twentieth of the whole. Occasionally the chlorite schist contains hornblende or actinolite, and thus gradually passes into an hornblende schist, or into an actinolite schist, of various aspects. These several substances alternate in fre-

* Where this schist is subject to the action of the sea, it presents shallow cavities strongly resembling the impression of a human foot. It is more remarkable that these are sometimes placed alternately in parallel lines, so as to resemble a series of the steps of an individual. As the Scythians showed an impression of the foot of Hercules, the Highlanders may be allowed the same indulgence for the footsteps of Fingal.

quent transitions; the thicker beds, which are those of the compound chlorite schists and quartz rock, being separated by the thinner micaceous schists and by other varieties of chlorite schist of a finely laminar structure. They are all remarkable for their evenness and regularity; never presenting those irregularities and contortions so conspicuous in micaceous schist, and which are of general occurrence in the western chain that extends from Lunga to Isla.

The circumstances under which the veins of trap are found, here and on the adjoining coast, are interesting. After passing Killean, on the coast of Cantyre, they almost entirely disappear in proceeding northwards. About the point of Craignish they again commence, and are to be observed in great numbers along this shore; increasing in frequency as we approach the great mass of trap that occupies so large a part of Lorn, and is connected with that of the Slate isles and of Mull. They present numerous examples, often highly picturesque, of those features formerly described as characterizing them in Mull and in some parts of Sky. The walls often project on the shore far from the surrounding cliffs of the stratified rocks, sometimes attaining the height of 100 feet, and being generally vertical with parallel sides. The artificial appearance they hence present, is much increased by the transverse prismatic fracture so frequent in trap veins, which gives them the appearance of masonry; while their resemblance to the ruins of castles is completed by the ivy that creeps about them, affecting peculiarly this situation, as it is a plant otherwise very uncommon on the western coast.

These examples may be added to others formerly adduced to prove that the prevalent trap veins of the western coast of Scotland, are processes diverging from the great masses so conspicuous in this part of the island.

THE ISLES OF ST. CORMAC.* CRAIG DAIMVE.

A SMALL group of islands lies off the point of Knap, to which I have given this general name from that of the principal one, known to the Highlanders by the name of Inch Cormac more, and improperly entered in the map of Scotland under the title of the More isle. I have not been able to discover the native designations of the smaller, but the omission is not of any moment. They are interesting, although trifling in extent, for the same reasons as the Craignish isles; forming part of the same series, and extending the general connexion of this subdivision, with each other and with the adjoining continent.

The largest island is scarcely a mile in circumference, and is of a very regular shape. It is perhaps more interesting to the antiquary than to the geologist, as it contains one of the most entire of the ecclesiastical remains now to be found in the Western islands. This building is however but little remarkable, except for its preservation, as it consists of a very small chapel only, with a cell attached, probably dependent on Iona. The dwelling and the chapel are included in the same building; the stone arch which covered the former being still entire, but the roof of the latter having decayed. The interior of the chapel is nevertheless in a state of preservation unusual among the ruins dispersed throughout these islands. The stone which supported the altar remains in its place; and in a recess on the south side, is another, covering a stone coffin, and sculptured, in the usual dry manner of the age, with a bas relief of a priest in his cope, but without

* See the general Map.

inscription. The piscina has been broken off from the wall, but is otherwise uninjured; being ornamented with a pattern of some elegance, and supported from below by four grotesque figures, in a style of design and execution sufficiently barbarous, but very usual in the works of these times. Four empty and rude niches are to be seen in the wall; the places, probably, of as many images which have been dislodged by the holy and iconoclastic rage of the Synod of Argyll. Besides these, there is a large cavity wrought in its substance, which appears to have been intended for purposes of concealment; a precaution not unnecessary in the times of St. Columba and his successors.

At a small distance from the chapel is an inclosure, containing a rude sarcophagus firmly built with stone and lime, and still very entire; at the west end of which is a sculptured cross now in a ruinous state. This may possibly, from its importance, be the tomb of St. Cormac himself; but it is, like the former, without inscription; so that the fame of its tenant has perished in that revolution of public opinion which has rendered the example of the eremite as little instructive to posterity as his life was useless to his contemporaries. Another cross is seen on the highest part of the island. It is now broken in two, but both the parts remain, and though much corroded by time, the sculptures are still visible. On the one side is the well known intricate pattern so common in all the sculptures of those days, while the other represents the crucifixion. Two women are standing by the cross, which is surrounded by three fleurs de lis: whether this is an accidental feature, or bears any relation to that country of which it is the emblem, cannot be conjectured. I have been the more particular in describing these remains because they appear to be scarcely known, even in the immediate vicinity; nor have I been able to discover that the industry of antiquaries has elicited any thing

relating to St. Cormac and his eremitical establishment, excepting, that like most of the saints of the Western isles, he was of Irish extraction.

It has been imagined that the existence of ecclesiastical remains in islands at present uninhabited, and their abundance in others now destitute of a place of worship, were proofs of the superior population of the Western islands in ancient times. But solitude and austerities were important parts of the devotion of the middle ages, and to these alone we owe such establishments as those of St. Cormac and the Shiant isles; while the consecration of buildings to sacred uses, was an essential character of the religion of those days. It is probable also that superior knowledge, and the influence of the apostolic character, in the early founders of Christianity in these islands, had given them the possession of much property, which was afterwards wrested from them by freebooters or savage chieftains who feared neither God nor man. Many of those buildings appear also to have been votive chapels, and it is probable that a large proportion of the twelve churches of Rowdill in Harris were of that nature. This conclusion seems justified by a group still existing in Barra, five being collected within one small enclosure; some of them being on so small a scale as to be incapable of containing above ten or twelve persons. Similar chapels, of which the votive origin is recorded, are known to exist in other situations. Such establishments can therefore only be considered as evidences of a different distribution of property, and as proofs of superior devotion, not of superior population, in the ages in which they were erected.

These islands are now uninhabited, but as they abound in rich pasture, are used for wintering sheep and cattle, being attached to one of the neighbouring farms on the mainland.

The strata which form the principal island are vertical, or if they have any prevailing dip, it is to the eastward,

like the Slate isles and those of Craignish. Their direction is pretty accurately north-east, and in this respect they correspond very exactly with the strata of the adjoining mainland. The predominant rocks are, as in the Craignish isles, chlorite schist, micaceous schist, and quartz rock; together with certain anomalous substances which will be described in detail hereafter. They present also the same alternations, with the same regular distribution that will be found to pervade the whole of this series. Among them is found a thick bed of limestone, which occupies nearly one half of the breadth of the island, or rather, one half of the breadth of the strata. Like the rest, it is vertical, and is generally of a pale or dark blueish grey, having in some places, portions interposed of a red colour. Its texture is between the granular and crystalline, and in some parts lax and arenaceous. This bed is not found in Isla, since the directions of these strata, prolonged to the south-westward, do not meet that island; but it occurs, as might be expected from its bearings, in Dana, where it is of similar dimensions and composition, and is accompanied by the same strata. It is not necessary to give any description of that spot, as the intimacy of its connexion with the mainland is such, that it can scarcely be said to form an island; being only separated by a narrow tide neck from the adjoining shore.

The smaller islands included under this title, present strata occupying a similar direction, but with a dip decidedly to the eastward; in which respect also they correspond with the rocks on the mainland; since, on this part of the shore, it will be found that the dips decline from the perpendicular towards that quarter. The substances found in them are, common quartz rock, an extremely dark micaceous schist composed of black mica with a very small proportion of quartz, chlorite schist, and a schist composed of chlorite and hornblende.

The rocks and islands which lie close to the point of

Knap have no names that I could discover; but, like that point itself, and the whole shore, they consist of similar strata placed in the same direction, with the same dips and with corresponding alternations.

The small island Craig Daimve, lying off the point of Keils, may be noticed here. It consists almost entirely of chlorite schist, containing imbedded nodules of a non-schistose substance, which gives to the whole compound a very singular aspect. These are formed of a mixture of hornblende and chlorite, containing distinct imbedded grains of epidote and of quartz in considerable abundance. They present a compound so singularly tough as scarcely to admit of being broken by any ordinary force.

The position of this little island, no less than the direction of the strata, would be sufficient to prove that it was a detached portion of the series that forms the mainland; a circumstance that will appear obvious hereafter when the whole of this series shall be described.

GIGHA AND CARA.*

The small island of Gigha, with its appendage, Cara, is situated between Isla and the west coast of Argyllshire; to the latter of which it lies in a parallel position, forming safe and convenient harbours for vessels navigating this sea. The length of Gigha is upwards of seven miles, and its breadth about two and a half; a dimension however which it attains but in one or two places: Cara is of a roundish irregular shape, and scarcely half a mile in breadth.

These islands, in a general view, are low, but interspersed with rocky eminences; some of which acquire the importance of hills, rising to the height of three or four hundred feet. The shores are every where surrounded by low rocks, reefs of which, extending round the coast, and into the channel that separates them from the mainland, render the navigation intricate. The soil is generally dry, while, being free from peat and little encumbered by heath, it is well adapted for culture, and is at present in a considerable progress towards improvement.

Gigha and Cara are formed of the same series of associated rocks already described in a general manner under the two preceding heads, but presenting a much greater variety of substances than any of those formerly enumerated. Hence they form a very important part of the series; while these islands become further valuable in the geologist's estimation, by extending the relations between the Argyllshire coast and the great insular tract of Jura and Isla.

The very even disposition of the rocks of Gigha, renders the determination of their sequence as easy and satisfactory, as the exposure of the edges of the strata over the whole surface of the island, facilitates the examination

* See the Map.

of their mineral characters. The general direction of these edges is north-east somewhat northerly, and their dip north-westerly; the angle of inclination to the horizon being generally about twenty degrees, but reaching in some cases to forty and upwards. In these respects it will be seen that the strata conform more or less accurately in direction to those of all the schistose islands which have already been described, though differing from the whole of them in the dip.

From the frequent alternations that here take place among the different rocks, it is impossible to assign the lowest place to any. This indeed is the general character of the whole series wherever it occurs. It may only be remarked, that quartz rock alternating with micaceous schist prevails on the eastern quarter, and chlorite schist on the western; and that, as far as the island alone is concerned, the former is therefore the lowest, and the latter the uppermost in place. But in the intermediate space, these three rocks are also found alternating, with the further addition of the various hornblende schists; the quartz rock however in a very minute degree only, the chlorite schist in extensive beds. This latter rock indeed, under various modifications, seems to form the principal part of the island; hornblende schist under different aspects constituting the chief part of the remainder. In a manner equally general it may be remarked, that the hornblende rocks are inferior in position to the chloritic, and that they follow the micaceous schist and quartz rock: but they are also found alternating with the former, and even constituting with them several ambiguous and unnamed mixtures. It would be an useless task to describe the order of these alternations further, since they seem abundantly inconstant, and perhaps not even very continuous according to the course of any given stratum.

With respect to the mineral composition of these rocks, it will be sufficient to enumerate the most conspicuous strata, since these, however varied, are still necessarily

ranked, for want of other names, under the leading titles of quartz rock, micaceous schist, hornblende schist, and chlorite schist; although the two latter often deviate considerably from the definitions.

There is nothing in the quartz rock or micaceous schist to call for particular notice. They are both extremely distinct in character, and the beds are of considerable thickness. The unequal action of the sea on these rocks where they occur on the shore, renders both of them conspicuous at a distance. The chlorite schist occurs under many distinct forms, but the most prevalent is fissile and scaly in texture; being often so regularly laminar as to admit of being used for slates. The other varieties will be better deferred till the whole series shall be collectively considered. The hornblende schist presents also many varieties, the consideration of which must be in the same manner deferred, but the prevalent beds consist of felspar and hornblende; scarcely schistose, and often resembling the greenstones of the trap family.

It is reported that copper has been found in Gigha; but on this subject I could procure nothing but hearsay and vague testimony, while there is reason to believe that pyrites, which occurs in many of the rocks, has been mistaken for it.

Common chlorite is found imbedded in the quartz veins which traverse the chlorite schist, as is usual wherever these rocks are found. Large concretions of green compact felspar are also to be seen in different parts both of the hornblende and of the chlorite schists.

Trap veins are to be observed traversing the island in various directions, but no where possessed of any peculiarities to render them objects of notice, after the numerous examples which have fallen under review in describing the other islands.

It was remarked at the beginning of this account that there was a general resemblance between Gigha and the accompanying island Cara, and they may indeed be con-

sidered as parts of the same ridge. But there is one doubtful circumstance in Cara, that cannot be passed without notice. At its southern extremity the beds of micaceous schist and quartz rock are immediately followed by a mass, apparently of common greenstone, consisting of an extremely hard and uniform basaltic base, with occasional particles of felspar intermixed. This rock has no tendency to the schistose fracture, and, notwithstanding the similarity of the ingredients, is as much distinguished in aspect from any of the varieties of hornblende schist found in Gigha, as by its external features and leading fracture, which display the vertical and imperfectly columnar tendency so generally found in the rocks of the trap family. The ambiguity respecting its geological character arises from the circumstance of its immediately following the micaceous schist in the same order as the hornblende schist does in Gigha; and from the fact that the vertical prismatic fracture occurs, in other instances, in those beds of which the alternation is unquestionable. That ambiguity must for the present remain, since the peculiar characters of this series, as it occurs on the adjoining continent, were not investigated until long after the examination of these islands, and no opportunity was afterwards afforded of re-examining Cara with the increased knowledge derived from that investigation.

GENERAL COMPARISON OF THE SCHISTOSE ISLES.*

In proceeding to the general examination of the connexions and relations of these islands, it must be remembered that they were classed in three subordinate groups, the Slate, the Quartz, and the Chlorite isles. On the subject of the first group nothing remains to be added except a few remarks on the beds of chlorite schist, which will find their place in describing the last subdivision; the relation of each individual to the whole being easily collected from the preceding descriptions. The internal relations of the several members of the second have been also sufficiently detailed. But the limited extent and small number of the islands included in the last subdivision, rendered it impossible to give an account of the series of strata to which they belong, as ample as its importance merits; while the history of these rocks could not be understood without reference to the mainland, where they occupy an extensive tract of country. The following sketch of the general extent, position, and prevailing features of the whole district, will render intelligible that which must have appeared obscure in the history of these spots; and from it may be supplied those minor details which were purposely omitted, as being, in their detached state, unsatisfactory. It will, from that, be seen, that the islands of the chlorite division all consist of the prolongations of the beds on the mainland; the variations of character and position in the strata of the several individuals, corresponding exactly with those of the continental strata from which they are prolonged.

This series must be distinguished by the name of the

* See the general Map, and consult Arrowsmith's Map.

Chlorite series, or *formation*, a term necessary to discriminate it from the series of micaceous schist with which it has hitherto been confounded. Its character will be found sufficiently remarkable, and sufficiently distinct from that of the micaceous schists throughout Scotland, to justify this new arrangement.

If a line be drawn nearly parallel to the southern shore of the eastern branch of Loch Fine, at a small distance from the sea, and prolonged to the western coast of Cantyre, it will represent, with an accuracy sufficient for the present purpose, the south-eastern boundary of this series; that boundary being coincident with the bearing of the strata. The corresponding parallel boundary to the north-west, will be found in the island of Shuna and on the adjoining mainland; the extreme visible portion of the series being the grey ridge of Luing and Seil. This boundary is rendered imperfect by the occurrence of the trap of Lorn, which overwhelms the chlorite series, together with the conterminous mass of clay slate that occupies the Slate isles and the adjoining continent; the indications of the junction of these being barely visible in the proximity of Shuna to Luing, in the grey ridge of the latter, and in a point on the mainland opposite to Torsa. It is evident that the boundary to the south-westward, across the strata, is the sea; while the corresponding one, to the north-east is, like the former, obscured; partly by the soil of the interior district of Argyllshire, to which the strata are prolonged, and partly by the great tract of porphyry which covers the stratified rocks in this quarter. Such is the geographical extent of that portion of this series to which the islands in question belong: it would exceed the limits of this investigation to pursue it further into the interior of Scotland, where it also occurs in a distinct manner.

In examining the lateral boundaries of this series, nothing can be added to the account just given of the north-western limit: but it is apparent that the termination is here definite as far as it is visible; the only vacillation

that occurs, being the single set of strata that forms the grey ridge of Seil and Luing so often mentioned and alternates with the clay slate of this tract. The southern limit however is unassignable; a great number of indefinite gradations and irregular alternations taking place, before the chlorite series is finally established to the exclusion of the micaceous schist which forms the southern part of Cantyre and the districts to the south of Loch Fine. This ambiguous tract however rarely exceeds two miles in breadth; in a few places it may extend to four.

Many opportunities of tracing these alternations are afforded, in the sections presented by the various shores of these intersected coasts. The micaceous schist possesses a very uniform character through the whole extent above mentioned; being generally of a greenish hue, so as slightly to approach to chlorite schist, without ever presenting very decided examples of it. Occasionally also it assumes a quartzose character, without actually passing into quartz rock. It appears to contain no beds of any substance, excepting some partial and irregular masses of limestone. In general it is much undulated, and in this respect it offers a marked contrast to the chlorite series, which is characterized by the great straightness and even parallelism of the beds.

The gradation between the micaceous schist and the chlorite series takes place by the occasional occurrence of one or other of the beds of the latter among those of the former. At first, a single one only will be found in a space of many hundred yards, but at length increasing in frequency, they become predominant; the micaceous schist gradually diminishing in such a manner as to be no longer perceptible except on close examination. During the progress of this change, the stratification, which, through nearly the whole extent of the micaceous schist, is so confused as to be scarcely distinguishable, becomes gradually so even and regular, that, in those cases where the angles of inclination are small, the

beds put on the appearance of a series of secondary strata. The deception is often very great, and is much aided by the thinness of the several beds which enter into the chlorite series; more especially by that of the quartz rock and micaceous schist. This contrast of character is one of the most remarkable features in the present series as distinguished from that of micaceous schist; the latter rock, in almost every instance where it occurs in Scotland, being confused, bent, undulated, and with difficulty distinguishable into strata; while the former, even in its vicinity, maintains an invariable regularity in every point throughout its whole extent. The resemblance to the secondary strata above mentioned, is also much assisted by the perpetual interchange and repetition of the different substances belonging to this series; each individual of it being succeeded by some other of the number, and no stratum occupying more than a few feet, while many of them do not exceed two or three inches in thickness.

The extreme breadth of this collection of strata, taken at right angles to the bearing, is twenty miles; and as the far greater portion of the beds occupy angles approaching the vertical line, from which the inclinations on both sides tend in opposite directions, it may be considered as the present thickness of the whole mass. Having examined the sections in every point, from one extreme boundary to the other, it may safely be stated, that, from a mean measurement of the dimensions of the separate beds, there are not less than 40,000 alternations within the space of this series. It will be a subject for future inquiry whether, admitting that all such strata have been originally deposited in a horizontal position, this can be considered as the actual and original depth of the whole deposit.

The general direction of the beds which form the whole series, is, as might be expected, to the north-

eastward; but under considerable variations which it is necessary to explain, as the discordant positions of the different Chlorite isles depend on them.

It was shown, that in Gigha, the bearings of the elevated edges were north-east, or a little more northerly. The same disposition will be found to pervade the corresponding prolongations on the mainland, and by this the forms of Loch Tarbet and Loch Killisport are determined; the boundaries of each of these being identical with the course of the strata. This portion lies near the south-eastern boundary of the series, and thus Gigha and Cara are also situated on the confines of the whole deposit. In proceeding to the northward, the line of bearing gradually assumes a more northerly tendency; the effect of which on the forms of the coast is also marked in the disposition of Loch Swin, and in that of the shore from Keils point to the extremity of Loch Craignish. This direction, as already mentioned in treating of the Craignish isles, is north-north-east, and thus these islands, as well as those of St. Cormac, appertain to a part of the series which lies at nearly equal distances from the middle and from the north-western boundary. In approaching still nearer to this boundary, the strata gradually assume a position still more northerly, which is indicated, as before, by the forms of the coast, while it is also visible in the strata themselves in numerous places. In Shuna, as was already shown, the direction becomes nearly north, the tendency to the eastward scarcely amounting to half a point; and with this, the small islands in the channel leading to Loch Melfort, which it was not thought necessary to describe, correspond. It was also shown that in this island a sudden flexure took place to the north-east by north; the only example of such a change which I observed throughout the whole extent of this series. That flexure is indicated on the

mainland also, in the position of the strata at Degnish point; but the occurrence of the trap at this place puts a stop to all further investigation in this quarter.

Throughout the whole extent of these varying directions, it is obvious that the changes correspond with those of the Quartz isles and of the Slate isles; and that a general parallelism is thus maintained under all the irregularities, by every member of the group of the Schistose isles at large, and by the strata of whatever nature that form the adjoining continent.

The variations which take place in the dip of the chlorite strata throughout their extent, are considerable, and merit a somewhat detailed consideration. Commencing at West Tarbet Loch, which, in a general sense, may be considered as the south-eastern boundary of the series, the dip is towards the west; in which respect it corresponds with that of Gigha already described. The same regularity is not however maintained on the prolongations of the strata, as may be discovered by examining the western shore of south Loch Fine. Here, for a certain space from Barmore northwards, the dip is frequently reversed; the strata thus often occupying the vertical line, and considerable irregularity being the result. But from Strandore, on this section, where the strata are vertical, to Loch Gilp, the north-western dip is regular; or, if there are any irregularities, they are so limited as not to be easily discovered. On the western section, on the contrary, both in South and North Knapdale, irregularities similar to those near Barmore, are found; although by far the prevailing dip of the whole series is still to the westward. These irregularities, like the former, consist in occasional vacillations from the eastern to the western dip, accompanied by vertical intermediate portions. Notwithstanding these vacillations however, the regularity of the strata and the parallelism and evenness of their alternations are never changed; nor are the reversals ever attended

with those contortions so common in similar cases in micaceous schist. It is nevertheless evident, that as the same prolonged strata do not throughout their whole course maintain the same dip, some flexure or fracture must take place in the intermediate points, which in this peninsula are rendered invisible by the soil of the interior country. It is interesting here to remark that the same character in a greater degree pervades the whole of Cantyre; since the beds of micaceous schist on its eastern shore have an eastern dip, while those on the opposite side dip to the westward.

If the irregularities thus enumerated, which bear a very small proportion to the whole extent, be omitted, it will be found that the strata are placed at low angles near the south-eastern boundary of the series; those angles rarely rising to above twenty degrees, and being in some places considerably less. Under the same general exceptions, the elevations gradually increase in proceeding northwards, till at length the prevailing position is vertical. This elevated position of the strata will be found to predominate in the tract which lies between Loch Swin and the western coast, and admits of easy examination on two sections, that of the various inlets of this coast, and that of the Crinan canal. After a certain space, attended by the usual vacillations, the prevailing dip is found to be reversed, tending to the eastward; and thus it is found disposed in the Craignish isles, where it first becomes permanently settled to this quarter, and in Shuna, where it has already been described. On this side also of the general vertical elevation, the angles subside as the strata retire from it, those in Shuna being as low as in Gigha, although in the reverse position. The same general inclination to the eastward has already been shown to prevail in the Slate, and in the Quartz isles. If now the whole series of the Chlorite strata be retraced, it will be perceived, that under minute irregularities, there is a line of vertical

beds, not however placed in the middle of the tract; towards which the strata converge on each side, both from the south-eastern and north-western boundaries.

It is now necessary to enter on the description of the several rocks which enter into this series; a task the more necessary, as these details were purposely omitted in treating of the Chlorite isles. The peculiar nature of these substances, no less than the peculiarities of general character just described, were the circumstances which induced me to consider the Chlorite series of this coast as distinct from that of the micaceous schist. It remains to be known whether any series analogous to this exists in other countries; but that can never be determined if every schistose rock of this character is conceived to belong to the series of micaceous schist, since investigation then becomes unnecessary. It remains for geologists to reject it, if they please, as a superfluous distinction; but, in the present state of this science, it is preferable to err on the side of extreme refinement, than to confound under general terms, details, the ultimate value of which must yet be unforeseen. That every member of this series does or may occur, either with the series of micaceous schist or that of gneiss, is no argument against the present division, since the same is true of many other rocks. The establishment of certain distinct series, in which a peculiar general order and association of a given number of substances is observed, is not one of the least improvements in modern geology. The importance of the *formations* of geologists is too well known to require defence.

In describing the several strata which enter into the Chlorite series, (or *formation*,) it appears expedient to divide them into two portions, those which are of most frequent recurrence and of the most constant character, and those which present various modifications, both subordinate in quantity and apparently variable in composition. The leading strata which give the character

to the whole series, will be found comprised under the following division, and they are placed as nearly as possible with some regard to their relative importance, or to the spaces which they respectively occupy.

The first of these is a schist thickly and imperfectly fissile; either consisting of schistose chlorite and felspar alone, or of these minerals with hornblende or with actinolite superadded. This rock shows no external marks of its fissile tendency, like micaceous schist or ordinary chlorite schist; that property being detected only by the hammer, to which it is at the same time extremely refractory. Where exposed to the air, and more particularly where it is washed by the sea, it assumes rounded forms, with polished surfaces in every part; indicating an uniform massive structure like that of greenstone. In this case it is equally undistinguishable in colour from that rock; the chloritic ingredient becoming black, and the felspar producing the same white specks that are visible in the rocks of this species. By the increase of the actinolite or of the hornblende, this stratum becomes so compact as scarcely to be distinguished from a hornblende or an actinolite schist; into which it seems ultimately to pass, being then undistinguishable from those rocks as they accompany gneiss. A remarkable circumstance is occasionally seen in these beds where they undergo the transitions in question, as well as in the ordinary hornblende schist that forms part of the series. They often present a prismatic fracture at right angles to the beds, the prisms being as regular and decided as in the trap rocks. When this bed therefore is uppermost, and attains the thickness of thirty or forty feet, while the inferior are thin and present the ordinary parallel stratification, it hence frequently assumes the aspect of a superincumbent mass of trap so strongly, that it requires great attention and minute examination to make the distinction. The deception is much aided by the composition, which is often similar

to that of greenstone, and by the aspect of the surface, which almost always resembles that of this rock even when the composition is different. The rock of Cara, already mentioned, presents this dubious character; but it is infinitely more marked in certain parts of Loch Fine which lie near the entrance of Loch Gilp. The vertical prismatic fracture was also pointed out as occurring in the grey ridge of Seil and Luing, which belongs to this series. This rock, under its various modifications, is the most conspicuous part of the series, and appears to form nearly three-fourths of it; the quartz rock being the next in quantity.

That substance varies much in colour, being brown, yellowish, white, or pale grey. It is sometimes compact and crystalline, in others fissile, arenaceous, or so mixed with mica as to present the appearance of micaceous schist when split in the direction of the laminæ.

Next in order is common scaly chlorite schist, at times arenaceous, at others silky, and either flat or minutely undulated; but in all cases splitting into thin laminæ, and generally very tender where exposed to the air. It is occasionally capable of being wrought for roofing slate.

Common micaceous schist forms the last of the essential beds of this series, being always flat and fissile, and frequently presenting a greenish hue so as at length to pass into the preceding rock.

These two last beds rarely exceed a few inches in thickness, and do not together seem to occupy a twentieth part of the whole series. I may remark, in concluding this enumeration of the essential and constant beds, that in some parts of the region occupied by them, the simple hornblende schist predominates over the thick and compound chlorite schist, usurping in a great measure its place in the series. This is more particularly the case in Gigha, and about the point of Knap.

It was already hinted that the usual order of arrangement among these several strata, is that of a constant

and repeated alternation of every member; but the micaceous schist is generally next to the quartz rock, and the thin chlorite schist accompanies the thick and compound variety. Thus the contrast between the beds of different dimensions, no less than the perpetual interchange of colour and the extreme regularity of the strata, render the whole very conspicuous, and strongly distinguished from the shapeless and contorted beds of the series of micaceous schist.

It is now necessary to enumerate the subordinate varieties which are found in this series; nearly the whole of which may be observed in Gigha, in the description of which they were purposely omitted for the sake of bringing the whole into one condensed view. The want of distinctive terms renders an enumeration of the ingredients and of their mode of disposition necessary.

The hornblende schist is found under the following different modifications:—

1. Simple schistose hornblende, either scaly or fibrous.

2. A mixture of hornblende and felspar; the former scaly, the latter arenaceous, and the structure of the rock schistose.

3. An alternating mixture of hornblende and felspar, both laminar; the laminæ very decided, and the rock easily splitting into thin slates.

4. A mixture of hornblende and felspar, so minute as to present an uniform grey aspect. The substances are scarcely distinguishable by the eye, and the rock is schistose.

5. A mixture of felspar and hornblende, not schistose in the fracture, but regularly alternating with all the schistose rocks.*

* This rock might, in hand specimens, be considered a member of the trap family. It is ranked here on account of its obvious and intimate affinity with these strata, not because we are at liberty to supersede the use of a mineralogical term when the substance to be described does not agree in its geological relations with those to which that is generally

6. Hornblende schist with mica.

7. The same with grains of green compact felspar interspersed.

applied. I am aware that the term primitive greenstone has sometimes been applied to similar rocks, but the confusion created by its use is considerable; since, according to the views of many geologists, the trap rocks, even when in the form of veins, or in other respects of an obviously later date than the stratified rocks in question, have also been distinguished by the same name; from the mere circumstance of a position which must in such a case be considered accidental. In these instances the adjective term, primitive, becomes fallacious; tending to increase a confusion which is already very inconvenient and injurious. Until that confusion shall be remedied by a more comprehensive and precise nomenclature, descriptions unaccompanied by specimens and drawings, will frequently be unintelligible. To prevent such mistakes, in the present dearth, and under the present ambiguity of terms, no method remains but the circuitous explanation here adopted. I am equally aware that the term hornblende schist is not universally applied to the schistose mixture of felspar and hornblende above described. In strictness it is only applicable to a schistose arrangement of simple hornblende. The term greenstone schist has been used for this rock; but it has also been applied to other schistose substances of different characters; for which reason it is prudent to avoid it, as well as all other terms, which, having been originally used in an ambiguous sense, can scarcely ever be limited afterwards. It is an additional objection to the use of the term greenstone, that having been most commonly applied to the rocks of the trap family, it is apt to excite associations which it is desirable to avoid.

Till more mineralogical names are invented, so as to distinguish effectually all the compound rocks, it appears still preferable, in descriptions of a country, where the leading objects are of a geological nature, to use such general terms as shall obviate any chance of misleading the reader respecting the affinities and positions of the rocks described. The ambiguity that might arise from them is prevented by describing the specimens; and thus the sense in which the term is used will always be understood, since the definition will accompany it whenever that appears necessary. To illustrate further these remarks, I may refer to a rock also occurring here, which, under one general and received term, includes many substances differing from each other more than the mixtures of hornblende and felspar do from common hornblende schist: namely, chlorite slate. This may consist of simple schistose chlorite, or of

The rocks which follow, consist of the most remarkable varieties of Chlorite schist.

1. Chlorite schist, formed of simple undulated, or straight scaly chlorite.

2. Schistose chlorite with quartz, sometimes finely laminar, sometimes granularly laminar, occasionally so compact as to be scarcely fissile.

3. Chlorite schist and felspar, either scaly or fibrous in the fracture, and schistose.

4. The same, except that the felspar is arenaceous, and scarcely distinguishable from quartz, without trial of its hardness, or observations on the effects of the weather upon it.

5. The same, containing in addition, distinctly imbedded crystals of common felspar. Similar felspar crystals are also found imbedded at times in common schistose chlorite.

6. Chlorite schist containing crystals or scales of black mica.

7. Chlorite schist and hornblende in a state of intimate admixture, the structure intermediate between scaly and fibrous.

8. Chlorite schist and actinolite.

9. Simple chlorite schist containing distinct crystals of hornblende.

In all these cases, additional variations take place from the occasional verging of the schistose chlorite to talc or to mica, from neither of which indeed is it at times easily distinguished.

The following are triple and quadruple compounds, and must for the present be ranked either with the varieties

chlorite with hornblende, with mica, with quartz, with felspar, or with more than one, or even two, of these ingredients. Still, in a geological sense, these several mixtures are received as varieties of one leading rock; and it is only in this sense that the privilege is claimed of applying the general term hornblende schist to the several varieties here described.

of chlorite schist or of hornblende schist, unless some mineralogist shall think it necessary to contrive new terms for them.

1. Chlorite schist, black mica, and felspar.

2. Hornblende, mica, and felspar.

3. Hornblende, chlorite, quartz, and green compact felspar.

The last which I shall enumerate are more ambiguous in their aspect than remarkable for their ingredients; the ambiguity being produced by the predominance of that which is on other occasions the least prominent ingredient, namely felspar.

1. A rock consisting of felspar of a texture intermediate between the granular and confusedly crystallized, or else of common compact felspar, interspersed with crystals of dark green or blackish hornblende, the whole mass being of a pale grey colour. It is at times schistose, at others it merely divides into thin beds, and subsequently by cross fractures into irregular prisms.

This rock ought not perhaps to be considered a subordinate variety; since it occurs in the several parts of the districts under review, in great abundance. It is also found occupying an extensive tract in the islands Luing, Torsa, and Seil, where it was formerly mentioned. In these, it has been shown to alternate with chloritic and micaceous schist, and with quartz rock; on the mainland it occurs with these rocks and with common hornblende schist; its boundaries being always distinctly marked, and the alternations taking place without gradation.

2. A rock with the general aspect and structure of the large grained granitic gneiss, but consisting of chlorite schist and felspar only; the latter forming distinct but imperfectly crystallized grains, very predominant, and only separated from each other by thin laminæ of the former. This rock is not strictly schistose, but breaks

like gneiss in an undulating irregular manner determined in some measure by the chloritic laminæ.

With regard to the two last named rocks, it is evident that we have no terms under which they can with propriety be arranged. It is true that the former possesses a certain analogy to the compound hornblende schist, and the latter to chlorite schist; but the differences, both in the relative proportions and in the disposition of the ingredients, are in both cases so great as perhaps to justify distinct appellations; a claim further supported by the peculiarity of their geological connexions. The invention of new terms is however a delicate task, and their reception is so much more frequently the consequence of authority than fitness, that it is better left to others, or to a time when the necessity will be more generally felt.

To these must be added the following substances, which do not in strictness belong to either division, though very nearly akin to the hornblende schists.

1. Schistose actinolite, spicular or scaly in the fracture.

2. Actinolite and felspar, the two ingredients occurring in a great variety of proportion, with consequent variations in the aspect of the rock.

3. Actinolite and felspar, with hornblende, or with black mica, or with both, superadded.

In terminating the account of the Chlorite series, it is necessary to add that some rocks of a different nature, not yet enumerated, occur in some parts of the tract which it occupies. As it alternates once with the clay slate of the Slate isles near its north-western boundary, so, in the neighbourhood of Crinan, a somewhat extensive range of fine clay slate and of graywacké beds, are found alternating with it. These rocks occur also in other places, but always in very minute portions. If these alternations detract nothing from the general integrity of the Chlorite series, they add another example to the numerous unrecorded associations in which clay slate and graywacké are

found. Beds of limestone are also to be observed, but always of very limited extent, and the summit level of the Crinan canal presents one accessible example of this nature.

HAVING thus finished the examination of the only subordinate group which required further illustration, it is necessary to proceed to a more general comparison of the whole with each other, and with those parts of the neighbouring mainland to which they seem to belong no less in geological identity than in geographical position. It is not necessary to notice the causes commonly assigned for these and similar geographic distinctions. Whatever expedients may be adopted for the explanation of the common features of hill and dale, of mountain and lake, the same are, with some exceptions, sufficient to explain the relations of islands to each other and to the neighbouring continents. It is in this case no ground for distinction that the valley is so much deeper as to admit the sea, and that the mountain summit is insulated among the surrounding waters.

The comparisons necessary for ascertaining the sequence of rocks throughout such a district as would exist were the bottom of the sea now exposed to view, must be drawn from the correspondence in position of the several rocks as they occur in the different islands, here to be considered as interrupted portions of one mass; and from tracing analogous or identical successions of rocks in those parts where the visible continuity is more extensive, and where less frequent interruptions take place. The latter source of comparison is so open and so little subject to error, that it requires no explanation. The former is less capable of rigid examination, as the proofs must be taken with some little latitude, arising from imperfections which do not at present admit

of being rectified; but as these have already been considered in the general remarks on the Trap isles, it is unnecessary to repeat them.

The first feature which attracts the eye in glancing over the general map of these islands, is that linear direction of the coasts already pointed out at the commencement of this work; the tendency of which varies between the north and the north-east, maintaining a general conformity to that of the adjoining coasts of the mainland, as well as to the prevailing bearings of the whole western shore of Scotland. From the Mull of Isla to the northern point of Jura, the tendency is more particularly to the eastward of north, as it will also be found on the adjoining coast of Argyllshire, and in the direction of the sea lochs by which this land is intersected. Among the smaller islands to the north of Jura it becomes more northerly, and here also the shores of the mainland maintain a general parallelism with those of the islands.

These prevailing directions in the shores of the islands, will be found to correspond in a great degree with the directions of the strata of which they are composed, and to vary in a great measure according to the variations of these lines of bearing. A similar general correspondence will be discovered on the mainland, between the direction of the strata and the general forms of the shores. There is consequently a regular series of connexions between the insular and the continental strata; the latter being prolongations of the former where they lie in the same line of direction, and succeeding them in parallel order when situated to the eastward. It is not however meant that either the outlines of the islands, or the mountain ridges of the mainland, are always conformable to the directions of the strata. This is doubtless true in many cases, as in Isla and Jura to a great degree, and still more remarkably in the Slate isles. But in Gigha, the

direction of the shores is oblique to that of the rocks, and the same disposition will be found to pervade the southern part of the peninsula of Cantyre.

If the lines of direction above mentioned are connected throughout, it will be seen that they are curved; and the reality of the curvature is proved by its taking place not in the interval between the southern and northern islands, but in the middle of Luing, as was shown in the description of that island. This curvature is however neither great nor permanent, nor is it such as to implicate all the parallel strata; as it is not found in the Garveloch isles which lie immediately to the west of Luing, and as the strata again approximate to their original direction in Kerrera, and in Lismore; this island lying parallel to the long lines of the Linnhe Loch, beyond which I shall not at present attempt to trace these connexions.

Although the directions of the strata are thus constant, with certain trifling exceptions which must be rather viewed as temporary undulations than as serious deviations from their general course, the dip is in different places, not only various in quantity, but reverse in position. In Gigha it is to the westward, while it is to the eastward, not only in Isla and Jura, but in all the northern islands. The point of change cannot be traced in the islands, since it must exist somewhere in the strait by which Gigha is separated from Isla and Jura. But it is easily discovered on the mainland, where it has already been pointed out in the preceding examination of the Chlorite series, so distinctly as to render any repetition here unnecessary. It must have been observed by the reader, that to whatever quarter the dip lies, the strata of these islands are rarely elevated to less than twenty degrees, and as rarely exceed sixty: we may therefore assume forty as a medium quantity, that being at the same time, in round numbers, perhaps the most common angle of general occurrence. It is obvious also

that at the points of reversal the strata must necessarily become vertical, as was proved to be the case in the central line more particularly.

The portions of the secondary strata occurring in these islands are so small, since they are only to be found in Seil and Inish Capel, that they scarcely admit of any general comparison. But if the scattered portions existing on the neighbouring continent be included with them, they will be found associated by a common feature which is not uninteresting. This is the general conformity of their dip, however detached they may be in position. From this it might be judged that they had once possessed a connexion more intimate, and were the remains of a more universal deposit; while the same circumstance indicates that their present separation is not the result of violent and local causes, but was produced by operations of a gradual nature. I need not however dilate on this subject, as the same circumstance was already pointed out in considering the general connexions of the Trap islands.

This appearance is further connected with another question of a general nature respecting the positions of strata, which is at present far too obscure to admit of a satisfactory solution. It has been shown that the secondary strata in Mull are deposited indifferently both on the edges and surfaces of the primary, maintaining nevertheless their own regular stratification. In the present case also, whatever the inclinations of the latter may be, the former maintain a generally regular western dip. Hence it may be concluded that they were deposited in these places after the primary rocks had assumed their present positions; and in this case they cannot have undergone any material subsequent derangements, but have originally been placed in the inclined manner in which they are now found. Nevertheless there appear to be satisfactory proofs that in other cases the secondary strata have undergone considerable changes of position since their original deposition; an example

of which will hereafter be pointed out in Arran. Certainly, these two circumstances are by no means incompatible, and there is little doubt that our increasing knowledge of the subject will hereafter confirm both views, by rendering us more intimately acquainted with individual instances, and consequently with the probable changes which the strata of the surface, whether primary or secondary, have undergone.

In comparing the substances that form the primary strata of these islands it will only be necessary to enumerate them in the most general manner, after the particular details already given.

They consist of all the primary stratified rocks except gneiss,* and among them quartz rock and clay slate appear predominant, micaceous schist being less abundant. These are accompanied by a series of rocks composed of chlorite schist, of felspar, and of hornblende, in various states of mixture and alternation; and lastly by graywacké and limestone, the last being the smallest in quantity. As the object of this comparison is to trace the regular rocks, and as nothing can be added to what was already said respecting the trap of the northern islands, I shall omit further mention of it.

It must have been remarked that the same alternations of rock which occur in any one or more islands, are found also nearly throughout the whole group, although in different proportions. If therefore we proceed laterally, by crossing the direction of the strata at right angles in any number of points, we shall procure sections of the alternations on those lines; assuming that they are all portions of one collection of stratified substances. A general correspondence will thus be found to exist throughout the whole; while no greater variations will be seen to occur on the lines of bearing, than is actually

* The portion of that rock occurring in Isla, is here passed over, as it is in small quantity, and its peculiar interest was already noticed.

found in cases where such strata can be traced in a continuous direction. Whatever these variations may be, they can all be resolved into changes of the thickness of the strata; in consequence of which, while some are attenuated, or even worn out in their courses, others increase in their dimensions.

In contemplating these alternations there is nothing more remarkable than the frequent change of substance, and the tenuity of the strata which are thus intermingled with each other; a change, not as in Seil or Shuna, confined to a small space, but extending from one end of the series to the other; from the eastern side of Gigha to the western border of Isla. It has already been seen that in consequence of this perpetual change, substances, generally considered as occupying distinct places on the surface of the earth in a regularly consecutive order, are here repeated without any distinction of priority or posteriority; clay slate for example being sometimes found above and sometimes below micaceous schist; supposed anomalies concerning which I need here add nothing, as they have been frequently pointed out in the descriptions of the several islands.

It is further interesting to compare the strata which, though found in different islands and at a considerable distance from each other on the line of bearing, appear to be only detached portions of one mass, the intermediate parts of which are concealed by the sea that divides them. Between Lunga, Scarba, Jura, and Isla, the continuity is so little interrupted and the resemblance so perfect, that there can be no hesitation in thus uniting them; while a similar identity will be found in Luing, Torsa, Seil, and Kerrera. It is less easy to trace some of the resemblances next to be pointed out, in consequence of their wider separation; but it is at the same time more interesting, as it explains the connexions of strata, the partial occurrence of which would otherwise make them appear as irregularities in a series in other respects very

consistent. These connexions must be determined partly by their relative positions on the general line of bearing, and partly by their resemblance in certain peculiarities of structure and connexion; that which is deficient in the one species of proof being compensated by the other.

It has been shown that in the Garveloch isles, a limestone accompanied by a breccia of peculiar character is found immediately following a peculiar schist distinguished by containing fragments of granite and quartz rock. The same beds, in the same order, although less conspicuously detailed, have been also shown to occur in Isla near Portaskeg; that which might appear dubious respecting them here, being rendered clear by their perfect exposure in the islands above mentioned. It has also been proved that if the line of direction of either of these is prolonged to the other, it will be found sufficiently conformable to the general bearings already described, to confirm the opinion derived from their resemblance, namely, that they are portions of the same, or of corresponding strata, of which the intermediate parts are either deficient or concealed beneath the sea.

In the same way it has been attempted to establish a similar connexion between Lismore and Isla, far removed as they are in position. Notwithstanding that interval, the perfect resemblance of the limestone of the former to that which occupies the middle district of the latter island, together with the conformity of their mutual bearings, seem to point to a similar connexion. I shall pursue these analogies and connexions no further; since a comparison of the details of the different islands as already given, will, with the assistance of the bearings and references laid down on the general Map, enable every reader to trace them for himself.

The next general object of inquiry is to determine the uppermost and lowermost of these collective strata,

and I need scarcely say that, as a preliminary to this inquiry, it is here understood, with many geologists, that the present strata, however at present placed, have been originally deposited in succession, the one above the other.

Wherever strata follow each other with an inclination directed to the same point of the compass, it is easy to suppose that the lowermost in present position have always occupied that place. But where, as in the case of these islands, the dip is in any instance reversed, the determination is not so easy. There are two varieties of the simplest case, that of a single reversal. If the strata diverge from any imaginary centre below the surface, on each side of the vertical, it must be concluded that the lowest are to be sought among the outer, and that the change of position has been produced by the subsidence of the middle and vertical strata, or by two elevations of the exterior and less inclined.* If, on the contrary, the outer strata lie in the reverse order, converging toward the vertical from numerous points beneath the surface, it follows that the middle strata are the lowest, and that the change of position has resulted from an elevation in the centre, or two depressions at the extremities of the series.† In such cases there should be a correspondence of the beds on each side of the centre, as far as such correspondence is consistent with the general limited continuity of strata, either in thickness or in composition. Where more changes than one occur in the dip, the determination of the lowest becomes proportionably more difficult. In the case of these islands, at least, there is but one reversal to account for, and it belongs to the first variety, that of divergence from a point beneath the surface; although many partial changes of that nature occur among the continental strata adjoining. In Gigha therefore, the lowest should on general principles be found

* Plate XXXII. fig. 4. † Plate XXXII. fig. 5.

on the eastern side, and in all the rest of these islands on the western. For if it be supposed that the whole was originally a single series of flat beds, it will appear that the present disposition was the result of a depression between the two portions that constitute Gigha and Isla, or else of two equivalent elevations at the extremities.

Besides the mode now mentioned, there are two others in which the question of superiority may in certain cases find its solution; the presence of granite in ascertaining the lowest, and that of the secondary strata in determining the uppermost rocks. But a little consideration will show that both of these offer but imperfect, and often very partial solutions of the difficulty. In the case of granite it is often found that the upper members of a series are in contact with it; a natural result of the irregularity of its surface and the obliquity of its position to the stratified rocks; while, in that of the secondary strata, it is obvious that they can afford no assistance unless where they follow the primary in conformable order. But whatever the value of these criteria may be, there can be no recourse to them here. Granite is not found in these islands, nor can any assistance be derived from the small portions of secondary strata which are visible. These lie in an unconformable manner on the clay slate or other primary rocks, and are therefore incapable of pointing out that which is uppermost. It is true that the same strata occur on the mainland adjoining; but, as far as I have seen, the red sandstone occupies there a similar relation to the primary strata, and is therefore incapable of removing a difficulty which must perhaps for ever remain unsolved, if the preceding hypothetical explanation is of no value.

The impossibility of determining this point, puts it out of our power to ascertain the original thickness of the mass of strata which is found in these islands; a circumstance, which, in other cases, for want of attention to the facts just mentioned, and to others which appear sufficiently obvious, seems to have been occasionally over-

rated by geologists. There is nevertheless sufficient evidence to prove an enormous thickness; since if the consecutive strata of Isla alone be considered, they will amount to many miles; their examination thus giving access to considerable depths in the crust of the earth.

But it is necessary to consider in greater detail the nature of the changes from which the actual position of these insular strata has resulted, and how far they are connected with the present forms of the land: with the elevations or the depressions which have produced those hills that constitute the islands, and those vallies which are now the beds of the sea.

By taking a line transversely on the bearing of the strata, which shall pass, for example, from the mainland through Gigha to Isla, or through Shuna and Luing to Lunga, a set of sections can be produced that may be indicated by those lines in the accompanying diagram* which lie above the black horizontal one representing the sea. To produce such a series of mountains or islands, four fractures of a set of horizontal strata may be imagined, accompanied by as many subsidencies, or elevations; since the same effects will result in either way. In this case, those parts of the diagram which lie below the horizontal line, will represent the original strata; and the directions according to which they must have moved to produce the present appearances, will be indicated by the circular arcs. It is plain, that in a similar manner, cases more complicated may be represented, this being the most simple example of a common dip.

Should the preceding statement appear probable, it follows, as just hinted, that the present thickness of the collective strata of any number of hills or islands, laterally placed, is not a certain measure of their original depth; since it may result from the repetition of fragments of a much more limited number in a new position; and this

* Plate XXIII. fig. 2.

rule may perhaps be applied to many cases where similarly enormous dimensions of the original strata have been imagined to exist.

This hypothesis may perhaps also in some measure remove a difficulty arising from the present frequent alternation of two or more substances, those for example of clay slate and micaceous schist; since, if the third stratum for example, represented in the diagram as in its original undisturbed state, be called clay slate, and the lowest micaceous schist, it is evident that the sequence, which is originally only the regular superposition of one rock above another, will under the assumed disturbance become a succession of alternations. It is nevertheless evident, that this diminishes the difficulty alluded to without removing it; since it cannot explain the frequent intermixture of these rocks in Lunga and Scarba, or in the other islands; so that the original argument deduced from those alternations remains in full force. One remark of a general nature still presents itself, and that is, the constancy and regularity of the direction of the strata, when such evident marks of disturbance are found in the dip. It will readily appear, that although we are unable to account for this difference, it is connected with a much more extensive train of phenomena which are indicated in the positions assumed by chains of mountains and the shores of continents in many parts of the world.

In examining the separations in the chain of the Quartz isles, a perfect correspondence of the opposite sides of the straits may be observed, whether in that of Lunga, in the Coryvrechan, or in the much longer channel that separates Jura from Isla.* No alteration in the elevations or positions of the corresponding strata can be perceived; the disjunctions appearing to have been produced by causes capable of cutting through the rocks without altering their positions, and the geological continuity remaining

* Plate XXIII. fig. 3.

in every respect perfect. This fact is sufficient to prove that neither elevation nor subsidence have been the efficient causes of the discontinuities in question, and that they have not been the result of any sudden and violent action. To a certain extent at least, there seem reasons for supposing, that they have been produced by a more gradual power, and we may perhaps, by combining both hypotheses, arrive at an explanation not very improbable. It is conceivable that the same change which gave the whole line of strata its present position, was accompanied by fractures across its direction in the places now occupied by these straits. Thus the geological continuity might remain, as now, unbroken; while the action of well known causes operating through a long period, would tend to enlarge the original openings to their present condition. Of this gradual enlargement there is visible proof in the present wearing of the strata on the sides of the straits. In the sound of Isla it is obvious to the most superficial observation, and is registered in a most impressive manner by the permanence of those trap veins which still remain standing alone on the shores like walls; monuments of the destruction of the softer strata.

INTRODUCTORY REMARKS ON THE CLYDE ISLANDS.

THE last division of the Western islands consists of those that are embayed in the great estuary of the Clyde. These, on a first view, appear rather to be associated by a geographical bond than by any extensive traces of geological affinity. Yet in this respect also it will be found that they present many important resemblances; being so related to each other in certain essential circumstances, that the description of one can scarcely be rendered thoroughly intelligible without having recourse to the rest. Even where the structure of any one of them requires no aid from a consideration of others, the general interest of the appearances is materially increased by a collective examination and comparison of the whole.

Arran indeed may in one sense be considered as an independent object; displaying a greater extent and a more perfect series of geological arrangement than any of the Western isles; and capable, to a great degree, of elucidation from its own internal stores. Yet even this island presents irregularities, if not difficulties, which can scarcely be explained, or placed in a satisfactory light, without resorting to the illustration that may be derived from the remaining islands and the adjoining continent.

Although the granite of Arran must be considered a solitary feature, that island possesses a common relation with Bute and Inchmarnoch, in the primary schists which are found in the whole; while one of its most interesting connexions with the mainland also, will be hereafter seen to consist in these rocks; which possess a very extensive community of character and position through a large part of the continent of Scotland. The red sandstone, with scarcely an exception, pervades the whole group; and under a very

interesting variety of position and of relations, which may be supposed to point, not only to a connexion once more intimate among them, but to an equally intimate, though more distant union between these islands and the mainland also. From the variety of character and position presented by these strata in different places, there will also be found to result some important geological consequences which would scarcely appear from considering them separately.

They present a further common bond of union in the Trap rocks, which, with scarcely any exception, are found in the whole. That deposit will also be seen to constitute a portion of an extensive range which is associated with the whole extent of the secondary strata; covering a great part of these on the mainland, and reaching, even from the Mull of Cantyre and the western coast of Ayr, to the eastern sea.

ARRAN.*

THE picturesque beauty and the variety of Arran, united to its accessible situation, render it as much an object of attraction to all classes of visitors, as the nature of its geological structure and details has long since done to geologists. From the rocky and rugged mountain, to the swelling hill, the open valley, or the green retired glen, it presents all that diversity of surface which is rarely found condensed into so small a compass, and, more rarely still, combined with an insular situation. The shores equally display all the varieties of maritime scenery; rising into bold cliffs, or subsiding into open bays, which are further diversified by cultivation and by wood, no less than by scattered farm houses, and by the occasional occurrence of the castles of former times. As it presents examples of that variety which is displayed on the surface of the earth, so it offers to the geologist an epitome of the structure of the globe; forming a model of practical geology for the instruction of the beginner and for the study of all.

The length of this island is about twenty miles, and the breadth about ten; while in consequence of the regularity of its form, the superficial area is nearly equal to the parallelogram that would result from multiplying its sides. The prevailing line of the shores is low, although in many parts they present precipitous faces, which seldom however rise to any considerable height. It is readily divisible into two portions, the mountainous and the hilly, of which the mineral characters are nearly as distinct as the external aspect.

The former occupies the north end of the island, being

* Ar, a field of battle; and Fin, the hero of the Gael. So say the Highlanders. Quidlibet è quolibet. See the Map.

bounded by an irregular line drawn between White farland and Brodick, and the remainder may be considered as the hilly division. The northern tract presents an irregular group of mountains, connected by ridges of a tolerably uniform height, and declining towards the shores to which they are nearest, without any distinct secondary set of elevations. They are intersected by deep narrow glens, the declivities of which are such as in most places to afford a constant drainage without suffering lakes to accumulate; no collections of water being found among them, except Loch Tana, Loch Iorsa, and Loch Huish. The mountain Goatfell is 2865 feet high,* and the principal summits in the vicinity are but little lower.

The hilly district consists of an undulating irregular land, which in various places descends into long declivities, but is, generally speaking, formed of one continuous elevation, occasionally rising into higher eminences and presenting but few valleys. The principal of these hills occupy a somewhat central position between Brodick and Kilmory, but their outline is tame and without character. The greatest elevation of this tract may be assumed at 1200 feet.

The characters of the mountains of Arran are grand, and their outlines picturesque and serrated; yielding in both respects, only to the superior magnificence of the Cuchullin hills. The granite of which they are composed rises into spiry forms, frequently bare of vegetation, and extending downwards in faces of naked rock into the intricate sections that divide these complicated ridges. The deep and rugged hollows thus formed, afford passage to the almost perennial torrents which rush with violence along them, forcing their way through the enormous fragments that strew their sides and encumber their surfaces. The sun seldom penetrates these deep

* From a mean of angles sufficient to correct the errors arising from horizontal refraction: barometrically measured by Professor Playfair 2945.

recesses, which exhibit to the painter all the sober and harmonious tints of reflected light as it is reverberated from rock to rock and from the clouds that occasionally rest on their lofty boundaries. It is in Glen Sannox, above all, that the effects arising from magnitude of dimension, combined with breadth of forms, and with simplicity of composition and colouring, are most strongly felt; and the sensations thence produced are similar to those which are experienced in the valley of Coruisk, which this glen resembles in every thing but extent, and variety of picturesque effect.* Independently of the subjects which these scenes afford for the pencil, the distant landscape, although beyond the reach of its powers, presents a striking display of variety and beauty; the rocky foregrounds contrasting with the gentler eminences of the lower land, the rich variety and fading tints of the distant hills of Argyll, the windings of the Clyde, and the splendent reflections of the numerous lochs and inlets which branch from it among the surrounding mountains.

In a different style of landscape, Brodick bay is no less beautiful, affording, in one point of view, a picture approaching to perfect composition in a degree rarely seen in Nature. The elegantly conical shape of Goatfell forms the extreme outline of this picture; while the middle ground consists of a rich valley sprinkled with trees and houses, rising up the sides of the lower hills on one side, and skirting, on the other, the beautiful expanse of sea which forms the bay; where the presence of occasional shipping, the rocky shores, and the activity

* The effect of silence as a source of the sublime, is strongly felt in these situations as on the summit of the mountain. It is the silence of that which is seen but is not heard, the fall of the foaming torrent, the business of the world below, too distant to reach the ear, that convey the impression. It is the silence of expectation amid the vastness of dimension and the appearance of power. It is like that awful moment which precedes the thunder or the volcano.

of fishing boats and of human occupations, present foregrounds of endless variety. Numerous scenes of minor detail, yet, in a different way, scarcely less interesting, occur at every step as we trace the shores, or follow the courses of the glens and streams which open into this beautiful valley.

While the western and southern shores of this island, exposed to the violence of the wind, are generally bleak, and bare of trees, the northern and eastern afford to the lover of landscape a continued succession of picturesque circumstances and interesting spots; in a style the more gratifying as it is of such rare occurrence on the sea coasts of Scotland. Rocks, mixed with trees and bushes of ash, oak, and birch, ornamented cliffs backed by the rugged spires of the mountains which tower above them, cultivated valleys, sandy bays, and the ever varying sea, present an incessant recurrence of picturesque objects; forming studies for the artist, even where they do not combine into the more perfect arrangements required for a picture. Among these, the scenery near the entrance of Glen Sannox is peculiarly striking, from the elegance of the conical summit of Kid voe, relieved by the depth of the valley and the darkness of the hills behind it. The geologist whose business it is to seek his amusements and pursue his studies among the more minute details of the surface, if unfortunately he is too sensible to these allurements, is apt to suffer his eye to wander from his proper subject, and, in the contemplation of the variety around him, to lose the order of the objects of which he is in search.

A scene of peculiar magnificence occurs at Scriden, near Sannox. A large portion of the mountain has fallen from above, strewing the long declivity with immense masses of fragments, which in their progress have covered the shore with ruins. The aspect and the combinations of these groups of broken rock are varied at every instant in proceeding along the shore; while in

every point of view they are equally grand and equally picturesque. As the eye ranges along the steep descent on which they lie, the retiring aerial perspective seems almost to obscure the summit, confounding it with the sky; while the spectator can scarcely avoid making a hasty retreat from a torrent of rock which seems about to overwhelm him with its ruins, and which even now appears in all the activity of motion. They who have had the good fortune to witness the avalanche of a mountain of ice, may perhaps imagine the effects of that, of which no phenomenon of less grandeur can convey an adequate conception.

It will readily be apprehended that under such a variety of surface, attended with equal variety in the nature of the subjacent rocks, Arran must present great differences of soil, and that its agricultural features will accordingly vary in different places. The hill pastures of the northern division, lying on granite, are heathy and unproductive; while they are also in many places encumbered with peat and interspersed with soft bogs, the consequences of imperfect drainage. Such is the height and density of the heath on some of the declivities, that it is difficult to force a passage through it; the desire of preserving the game, consisting of grouse and black cock, with which the island abounds, having induced the chief proprietors to prevent the practice of burning it, and the consequent stocking of those tracts with sheep; a system of pasturage which is incompatible with the existence of these birds. The soils on the higher parts of the southern tract, present similar characters; although the subjacent rocks, consisting chiefly of red sandstone, trap, and claystones, of which the surfaces are often covered with clay, prove that, under a greater degree of care than has hitherto been expended on them, they admit of valuable and permanent improvement. As in other neglected and undrained places, that soil is so encumbered with peat as to be useless; although, in many parts, it would advantageously admit the plough, while it affords

great facilities for drainage, so as to lead at least to a considerable amelioration of the pastures. Hitherto, the agricultural system of Arran has been of the worst and most antiquated description; the population also having remained without improvement in habits or in industry, while their surrounding neighbours were making rapid advances in civilization. The pernicious practice of illicit distillation and of consequent smuggling, to which the situation offers strong temptations, has greatly contributed to the depravity of the people, who, in losing some of the characteristic virtues of the Highlanders, appear to have acquired in return, only the vices of that civilization to which they have so free an access.

In the alluvial vallies and on the declivities which face the sea, even at a high elevation, soils of good quality are to be found; circumstances to be expected from the nature of the materials which occupy those vallies, and from that of the rocks on most of these exposures, which consist of schists, of trap, and of red sandstone, the latter including in some places, beds of limestone. These tracts are also generally in a state of natural drainage, in consequence of their declivities; and it would require, in many cases, but a small addition of expense bestowed on this object, materially to augment the arable land of the island.

In general, the cultivation of this arable land has been hitherto carried on by the smaller tenants, in the ancient manner of common holdings; these farms presenting an appearance of neglect and slovenly management exceeding that of any of the islands formerly described in this work. The effect of moral causes and of bad arrangements in suspending the progress of improvement, is no where else so visible in the Western islands, since every advantage appears to be concentrated in Arran which is compatible with its nature; an abundant supply of fish, a comparatively southern climate, a ready market, easy access to coal, lime, and manure, and the

immediate example of a neighbouring commercial and highly improved country. A new system has however been recently introduced, by the extension of farms and the introduction of opulent and intelligent tenants from other districts; and a few years will probably therefore see Arran rise, like Isla, to an equality with the most improved of the surrounding country. The facility of communication with the commercial towns of the Clyde, which has recently been given by the introduction of steam boats, will doubtless also tend shortly to produce here that impulse which it has already given even to the most remote shores of this complicated estuary; and it is to be expected that the natural beauties of Brodick will in no long time render it, like Rothsay and Largs, the summer resort of the opulent inhabitants of this populous and wealthy country.

Extensive coppices of natural wood are found in different parts of the island, and, in almost every place, shelter is afforded to wood, such as to enable it to acquire a luxuriant growth. Profit, no less than ornament, would result from the extension of planting; but the non-residence of the proprietors is here, as elsewhere, the obstacle to those improvements which might, in the course of no long time, render Arran one of the most picturesque and engaging tracts throughout Scotland.

ARRAN, like most of the Western islands, possesses many specimens of those antiquities which, though little interesting when individually considered, serve, as in other situations, for records of the tribes that erected them, and present almost the only historical traces of the early inhabitants of this country. When the alterations of language resulting from time, foreign admixture, migration, or conquest, have destroyed the chief proofs of the connexions and descent of rude nations; the peculiarities of their worship, of their

systems of defence, and of their funereal usages, as indicated by the permanent monuments which they have left, lend a valuable light in assisting us to trace their original identity; as, in a more advanced stage of refinement, that may be deduced from the peculiar characters by which their ideas in the arts are marked. By this help the antiquary penetrates the obscurity of past ages, and dispels the gloom that hangs over times of which even the traditions have vanished in the revolution of years. Rude sepulchral pillars, urns, stone chests, cairns, dunes, circles, and cromlechs, thus mark the common origin of the Celtic tribes which peopled Gaul and South Britain, and occupied even the remotest of the Scottish isles. Arran contains examples of all these monuments; and here, as in other parts of Scotland where they abound, their permanence may in some measure be attributed to the rude and uncultivated state of the ground where they are situated; neither the course of the plough nor the wants of architecture having yet presented causes or motives for their obliteration or removal. But their preservation in Scotland must be partly attributed to more interesting circumstances; to the respect which the inhabitants entertain for sepulchral monuments, and to the superstitious feelings, not yet quite extinct, from which they deprecate the removal or disturbance of the ashes of the dead. If it is no longer a rule for the passing traveller or solitary shepherd, to add a stone to the monumental cairn, still the hoary pile remains with all its ancient moss unviolated; a frail structure, yet often more permanent than the loftier mausolea of recent times.

A considerable number of erect monumental stones exists in various parts of the island; one of which, by the road side at Brodick, and two equally remarkable in a field not far distant, are particularly conspicuous for their magnitude and position. These stones,

frequent through the Highlands of Scotland, are the rude στῆλαι of our Celtic ancestors; the origin, it is probable, of those which the arts of Greece adorned in after times with sculptures and inscriptions. Unfortunately, the ignorance of letters which prevailed among the ancient Caledonians, leaves us in the dark both as to the periods of their erection, and the objects to which they were dedicated; since, with the exception of those sculptured stones which seem to have been erected after the retreat of the Danes in later times, neither emblem nor inscription is found to record the fact which they were meant to perpetuate, or the name of him who lies below.

Not far from Lamlash bay, an irregular collection of apparently ruined cromlechs still exists. The barrows in Glen Cloy bespeak a sepulchral origin, and it is equally probable that two very large cairns at the south side of the island cover the ashes of chiefs of higher fame and greater power. In ancient and classical times, we are informed that the ashes of kings were protected by a mound of superior magnitude; "extructo monte."

In almost all cases, similar erections, which are found abundantly in Britain, as well as in numerous parts of the northern division of Europe and Asia, have been found to conceal urns, stone chests, or other receptacles of the dead body; leaving little doubt as to their original destination, and pointing out, as far as such proofs can, the common origin of the nations from which the prevailing population of Europe has been derived. One of the cairns in the southern quarter of Arran is remarkable for a circumstance of rare occurrence, namely, the remains of an enclosure of stone with which it appears to have been surrounded. In this respect it reminds the spectator of the tomb of Patroclus, which seems also to have been a cairn or mound of earth surrounded by an en-

closure; that which in the progress of refinement became the περιοικοδομὴ and ὕπαιθρον by which more artificial monuments were afterwards protected.

Some imperfect remains of circular structures are also to be seen towards the southern end of Arran, which are, as usual, imagined to be Druidical places of worship. There is little to be said in the present day on the original uses and objects of these edifices, if edifices they may be called; as the subject has been long exhausted by antiquaries, and as, to imperfect evidence in favour of their religious destination, there is only evidence equally imperfect, in support of other purposes, to oppose. Yet it may be suggested, that the circular form is by no means a proof that all these buildings had a common object. The original forts were frequently circular, and this method of building, obvious, and economical in respect to the proportion between the space and the enclosure, appears to have been extended to other works, whether for the habitation of the people, or the defence of their flocks and herds from wild beasts. The frequency of the circular method of building among nations of existing savages, gives countenance to this supposition. It will be difficult else to account for the numerous remains of circular walls which are often found condensed into a small space; without the improbable supposition that many temples were crowded into one spot, or that the whole population of such a tract was occupied in religious worship. Cornwall exhibits some of the most remarkable examples of this fact; the high moors which lie round Roughtor and Brownwilly being covered with remains of circular buildings, often of very small size, and frequently accumulated together in a narrow space. The great variety in the size of these, as well as in the strength and bulk of the materials of which they consist, renders it probable that some were dwellings; while others were perhaps sheep folds, and a third, of larger dimen-

sions, places of defence. Greater splendour and greater magnitude, together with certain peculiarities attached to many of the most remarkable circular remains which have been described by antiquaries, bespeak the probable religious destination of those few; and, among these peculiarities, perhaps none are much more striking than the extended lines described in the specimen in Lewis, where it is evident that ornament and not utility must have been the object. In a similar manner, the placing of one enclosure within another, such as the square within the circle, or the addition of the single central stone, of the avenue, or of the cromlech, may be conceived, on good grounds, to be sufficient characteristics of the religious edifices, and as serving to distinguish them from the more numerous circular remains for which no probable uses but those above assigned can be suggested. There is a witchery about Druidism which seems often to have carried its modern worshippers too far.

Near Tormore are to be seen some caves in the sandstone, the supposed habitations of traditionary heroes not a little problematical. Fingal, like our Arthur, the ubiquarian king and warrior, is said to have occupied them during his hunting excursions. It is not improbable that they have been inhabited in later times; as they are much better adapted for human habitations than almost any caves in the Western islands, being dry, light, and convenient of access; while they are capacious enough to receive a large community. It is not long since the caves of Isla were inhabited, and those of Bridgenorth have been converted into commodious houses in the present days. In such circumstances, the holes which, in the caves of Arran, seem to bespeak contrivances for cookery, may have been made; while the sculptures, as they are called, consisting of rude lines scratched in the soft rock, are more likely to be the work of the children who herd

the cattle along this open shore, than that of the Fions. They are not in any other respect interesting, as their dimensions are insufficient for grandeur, and their smooth uniformity of surface precludes all picturesque beauty; while, being thoroughly illuminated, they are deprived of that uncertainty and obscurity which is, in these cases as in many others, a great source of the sublime.

The castles of Kildonan, Loch Ransa, and Brodick, remind us of the history of more modern times, although, as far as can be discovered, the precise date of neither of these buildings is ascertained: it is sufficiently plain that they are of no high antiquity. Little of Kildonan remains, and that little, consisting of a solitary square tower of inconsiderable dimensions, is not interesting. The castle of Brodick is connected with historical facts which must always render it an object of interest. But the remains of that fortress which Bruce wrested from the hands of his enemies, have disappeared and been replaced by later erections; while even these have, in the lapse of time, been at length modernized into the present habitable mansion. The castle of Loch Ransa remains unsophisticated, but its apparent antiquity, if we may judge from the style and execution of the architecture, is not great. It is however said to have been a royal castle in the early part of the fourteenth century. It is still in a tolerable state of preservation, and might, with no great labour or expense, be again rendered habitable. This building is by no means picturesque in design, although in its present situation it conduces much to the picturesque appearance of the little bay in which it is situated; giving a centre of unity to the whole, and offering to the artist a circumstance of moral and historical interest, of which, among these solitary and deserted scenes, he has often occasion to regret the absence.

Those who would enjoy the scenery of Loch Ransa

in perfection, should visit Arran during the season of the herring fishery. On the calm sea, in a fine summer evening, the whole water is covered with boats and vessels; the dark sails of the former, no less than their beautiful pyramidal outline, sprinkling the whole blue expanse in every variety of combination and of magnitude. Within the bay, the different groups are disposed nearer the eye in a thousand picturesque assemblages, varying at every moment as they are hoisting their sails to stand out to sea, or as they run alongside the sloops where the flag is flying to receive their cargoes. On shore, crowds of men, women, and children surround the sail tents, where the smoke of the fires scattered along the margin of the water, is ascending to the hills; mixing with the evening mists, and contrasting with the yellow sky of the setting sun.

The traveller who has visited the ancient castles of Wales or of England, will experience considerable disappointment on meeting with those which are scattered throughout Scotland; so far inferior in magnitude, and so seldom characterized by those irregular, though picturesque, arrangements of the architecture which render the former so interesting, and so susceptible of all the effects which the art of painting has the power of bestowing. They are in fact but castellated mansions; rarely sufficing for more than the habitation of a small family, and destitute of all the complicated defences, and the provisions for the garrison of troops, which alone can produce the romantic effect and excite the historical recollections that give to buildings of this class their principal interest. Their most frequent plan is that of a square tower, of rude but solid masonry, divided into three or four stories; the lowest, and sometimes a greater number, being vaulted. The windows are narrow, as is the door way. Where they are of greater extent, an area is sometimes added to the tower, enclosed also with a strong wall, and containing some

subsidiary apartments or additional houses. In other cases, the buildings occupy more or less of the inner side of a similar enclosure, leaving a small space in the middle. In consequence, apparently, of more recent additions, the area, or the group of building, occasionally assumes a more complex form, but the general style and plan continue the same. In a few instances, as at Dunstaffnage and Duart, a sort of bartizan is constructed on the top of the enclosing wall, for the apparent purpose of defence; but there are rarely any flanking defences, nor is the gate ever protected by machicolations or lateral towers; the only internal mode of annoyance appearing to be from the windows; occasionally from loop holes, although even these are uncommon. It does not appear that the bow and arrow was in use among these tribes, a fact somewhat remarkable in the military history of the Celtic nations; nor, in more recent times, has it appeared that they depended on fire-arms. Excepting the battery on Cairn burg, and a few pieces of ordnance mounted on Duart, on Dunstaffnage, and in one or two other places, the use of heavy guns appears also to have been little known to the Highlanders, even at a late period. It is rare to find any traces of architectural decoration in these buildings, and it is also worthy of remark, that in no instance is there the appearance of chapel or oratory, a feature very prevalent in the ancient castles of Wales and England. Among these chieftains indeed, religion appears, from many other circumstances, to have been an object of very little attention. These remarks, with slight exceptions, apply to the castles of the more powerful chieftains as well as to those of the smaller chiefs; nor is even the majority of the royal castles distinguished by marks of superior wealth, or by contrivances for better accommodation or more secure defence.

In the maritime Highlands, as in the isles, the situation of these buildings is generally on a rock overhanging

the water, or on some small island at a short distance from the shore; the warfare of those days having been carried on by sea, and the usual incursions being of a piratical nature. In the interior, they are often situated in a similar manner in lakes. Their present situation, compared with that which they have evidently occupied at first, often indicates to a geologist the changes which the shores and which the lakes have undergone; the island having been often converted into a peninsula, and that building which was surrounded by water being now situated on an alluvial flat of shingle, or of moory or meadow land. Kilchurn, in Loch Awe, and Carrick castle, in Loch Long, present, among many others, examples of these revolutions. The poverty, no less than the insensibility to convenience, of even the most powerful chieftains, is strongly exemplified in the meanness of these buildings, whether strong houses or fortresses; and it is scarcely an exaggeration to say that Caerphilly alone would contain all the castles of the maritime Highlands.

Having, in the description of Rum, given a slight account of the formation of those clouds called parasitical, one of the most instructive meteorological phenomena to be seen in mountainous countries, I may here add another example, differing in some circumstances sufficiently remarkable to merit description. Leaving Loch Ransa at six in the morning, with a light air from the westward, a thick fog with a dead calm came on, and the vessel was unable to make any way. Being desirous to reach Goatfell at an early hour, the boat was rowed along the shore, with the intention of ascending from Corry. Before arriving there, a fresh breeze sprung up from the eastward and the fog around us disappeared. On ascending the mountain however, I perceived that the place in which the vessel had been left, was covered with a dense round cloud which rested on its surface, occupying a space of

three or four miles in diameter, and reflecting the white light in a solid and silvery form. But the same fresh breeze which I had experienced in the boat, covered all the rest of the sea; terminating precisely at the limits of the cloud, which, for the space of three or four hours that I observed it, seemed to undergo no change of form or dimension. The objects I had in view being accomplished, I returned to the shore, and got under sail at two o'clock; steering towards the cloud, but with little hope of finding the vessel, since the fog in which the boat was involved on entering it, was so thick as to render it impossible to see fifty yards ahead. Scarcely however had we entered the calm which reigned within the whole space covered by the cloud, when, a sudden breeze springing up from the westward, the mist disappeared, and the vessel's sails were seen close at hand and just beginning to fill on the other tack. On inquiry it was found that she had been completely becalmed the whole time, and had not made an inch of way since the morning, while all the ships from the southward, even within a mile, had been standing up the Clyde with their sails full from the south-east.

The occurrence of analogous appearances in mountainous countries is common, and has been frequently remarked by Alpine travellers; but in those cases, the production of partial currents, or their diversion from a rectilinear course by the interference of high summits, seems generally to afford a ready explanation of these phenomena. Even these causes however, will not account for all the complicated appearances which occur; since I have sat for two hours on the top of Ben Lomond, at an elevation considerably greater than that of all the neighbouring hills, when not even a feather would have stirred, though a gale of wind has been blowing all around, carrying the clouds in hurrying mists above and on all sides, while the lake below was breaking in foam against the shores. It appears equally difficult to explain the present case, since the sudden termination of the easterly breeze

could not have been effected by the position of the land; certainly at least not by its mechanical interposition. But the complicated nature of atmospheric currents has been hitherto but little investigated and ill understood: it is one of the many unexplained points in meteorology which must be left for future investigation. As the subject however is interesting, I shall add to this instance some other remarkable examples of a parallel nature which occurred during the investigation of the Western islands. They all present cases of partial winds, which are well known to mariners, but have not experienced that attention from philosophers which their singularity merits. They do not appear to admit of explanation by any theory that has yet been proposed, and are evidently independent of differences of temperature, or of any differences of gravity or density in adjoining portions of the atmosphere.

The rising of sudden and local squalls in a tranquil atmosphere, is one of these phenomena, which may be experienced in great perfection in most of the sea lochs of the western coast, and is, in particular, frequent and violent in the deepest and most mountainous; as in Loch Hourn, and still more, in Loch Scavig. When the whole atmosphere appears at rest, and the sea is like a mirror, a gust of wind will descend with a rapidity and suddenness resembling the blow of a hammer; often momentary, and rarely blowing for more than a few minutes in one direction. The navigation of these lochs becomes thus extremely dangerous, particularly to boats; while even vessels of large size are sometimes brought in an instant to their beam ends. At Fort William these squalls sometimes emulate the effects of a West India hurricane; sloops having been blown up dry on shore; while it is not unusual in these situations to see boats on the beaches carried away by the wind and broken to pieces.

The following presents a remarkable instance of the permanent and partial currents which are so frequent on this coast, as they are in similar situations elsewhere.

In sailing up the Sound of Sleat, a dead calm was observed to reach from Airdnamurchan point to Loch Hourn. Immediately succeeding that, was found so smart a breeze from the westward, that the vessels passing through it were obliged to lower their topsails and reef their mainsails. Further to the northward, the calm again recurred; the line of separation being so decided, that the vessel in which I happened to sail ran through the breeze at the rate of eight knots an hour, entering the calm with such velocity as to bring all her sails suddenly aback. This line of wind was about two miles in breadth, and lasted for upwards of three hours; being accompanied by a parallel line of clouds, a circumstance generally attendant on partial winds, while the atmosphere on both sides was clear and blue.

It does not always happen that these winds proceed in a straight direction: on the contrary, they are frequently curved; the curvature taking place laterally, or parallel to the horizon, or even assuming directions more complicated. Such curvatures are sometimes indicated by the appearance of the water, at others by the trim of the sails in the vessels which are under the influence of the winds. On one occasion in Loch Hourn, three parallel lines of calm were observed to alternate with the same number of zones of rough water, extending across the whole loch, and at right angles to the course of the breeze. To be satisfied respecting the actual direction of the wind in these points, I caused the boat to cross the whole, using the oars in the parts becalmed. Thus it was found that we went before the wind through all the breezy parts; the middle of each zone, of which the smallest was not more than 100 yards in breadth, being attended with as much wind as the boat could well carry, and the margins diminishing gradually till they subsided into a perfect calm. This appearance lasted for an hour or more, beyond which I had no opportunity of watching it in a satisfactory manner. It can only be accounted for by supposing the stream of air

to have moved in an undulating plane, so as to have touched the surface at the points which presented a convexity downwards. It must indeed have often been observed, that currents of air, even on shore, are curvilinear; and thus only can we explain a circumstance by no means unusual, particularly in summer, when such irregular winds appear to be most prevalent. This is, the occurrence of a south or of a westerly wind in a particular tract, when the general wind is from the east, and when that is indicated, even in the particular spot where it does not exist, by the peculiar well known colour and aspect of the horizon and of the distant hills. There is no doubt that in these cases, partial differences of temperature in the surface of the earth will induce such variations, and they accordingly vary with the time of day and the position of the sun. It is equally certain that the squally winds are often produced by reverberation from mountainous land, or by the confinement of the current in a narrow passage; but as all the same phenomena take place in the open sea where such causes do not exist, it is obvious that there are also causes of a different nature still unknown to us.

In concluding this sketch I shall add one case of a still more intricate nature, and, at present, equally defying our powers of explanation.

In passing down the Clyde, and being off the point of Dunoon with a south-westerly wind close hauled, a sloop was observed standing up in an opposite direction, in the same manner and on the same tack, each having a fresh breeze. To ascertain the proximity of the two opposed currents, our vessel was caused to run alongside of the other and to pass within fifty yards. It was thus discovered that there was no line of smooth water between them; whence it was evident that these opposite and rapid streams of air were in contact. At some distance under the Ayrshire land, the vessels were all becalmed. It is evident that those which were crossing this double current, must have been at the same time taken suddenly

aback, experiencing a shift of wind which in fact did not exist. On reaching the lighthouse at Toward point, a strong breeze from the north-west was found blowing down the Sound of Rothsay, so as to oblige the sloops in it to lower their gaff topsails; while, from the middle of the Clyde, other vessels were seen standing for that passage, also before the wind. Owing to this singular concurrence of winds, the boat was taken ashore, in order to observe the effects more distinctly from a higher elevation, when it was evident that all the vessels coming down the Sound of Rothsay were suddenly taken aback on entering the open part of the Clyde, while the same effect happened to those which were steering in the opposite direction for the Sound. At the same instant of time therefore, there were four fresh breezes blowing from four opposite points of the compass. This appearance was watched for near two hours. It would have been interesting to have observed the nature of the confusion which took place at the point of general intersection; but the lateness of the evening rendered it impossible to carry the boat through all these currents in such a manner as to have ascertained this point in the only practicable and satisfactory mode.

It is obvious that no theory of a vacuum, or of a mere difference of density, is capable of explaining cases so complicated as this, which if it does not often occur in a manner so very decided and remarkable, is, in a general way, sufficiently known to mariners.

While on these subjects I shall be excused for introducing another circumstance very conspicuous in Arran, which does not appear to have met with the attention it merits; although individual instances much more remarkable have been recorded: it relates to the colour of water. All the small streams that run down the sides of the granite mountains, in Glen Sannox, Glen Catcol, and elsewhere, are of a sea green colour, possessing at the same time the most perfect transparency. The ab-

sence of peat on the stony surfaces whence these waters are collected, prevents them, at least in summer and in seasons of ordinary dryness, from being contaminated by the brown colour so general in the Scottish rivers. They thus present a state of purity rarely met with in similar situations; nor is there any reason to doubt that they are as free of contamination as rain water has ever been found; certainly free from all soluble matter capable of communicating its own hue to them. The quantity of colour is such as to be perfectly sensible at the depth of five or six feet: at ten or twelve it possesses considerable intensity. On comparing it with sea water in similar circumstances of depth, it appeared to be fully as green. The whiteness of the bottom on which the stream flows, is essential to this observation; and the rarity of that occurrence in fresh waters, is probably the reason that this phenomenon has been generally overlooked; sometimes, even denied. The courses of all these streams are on a bottom of white or grey granite; and as long as they flow over that rock, the colour is visible; vanishing when they arrive at the schist or the red sandstone, the powerful colours of which are transmitted, so as entirely to obscure their natural and delicate tint. The same rule holds in sea water, which, within small depths, and at rest, is only green when on a bottom of white sand. In greater depths the colour varies, according as the effects arising from the nature of the bottom, are modified by different circumstances; the chief of which are, the varying intensity of light and the different degrees of agitation. Under favourable circumstances of this nature, and of the spectator's position, the brown colour of rocks at the bottom, is transmitted through many fathoms of sea; a fact well known to the mariner who, on unknown and rocky shores, is stationed aloft to direct the course of the vessel. In less favourable cases the colour of the bottom becomes invisible at small depths, and the same mass of water

which was brown by transmission of the tint of the rocks below, becomes green. In all cases beyond a certain depth, it is always green, as it is in a breaking wave; the bottom colour ceasing to be transmitted in both cases, and that which belongs to the water alone, or its proper hue, acquiring the predominance. This statement however implies, as before observed, a certain state of the sky and of agitation; circumstances affecting the natural colour of the water, either by reflection, or by the multiplication of small shadows; and well understood by those artists who have attended to marine scenery, or have studied the works of the Dutch painters in this line.

It has been said, that if fresh water is green, that colour should be more frequently visible. But, in this country at least, it is rare to find, either in lakes or rivers, a white bottom; that being blackened in the former by mud and aquatic vegetables, and scarcely any beds of quartz or granite occurring in the latter, except in a very few situations and for short spaces among the Highland mountains; in all of which, wherever they are free from peat water or suspended clay, the colour is invariably green if the depth be sufficient. It is only in dry seasons that the two obstructing causes last mentioned are absent, and it is only in such cases that the fact can be observed.

But there is another case distinct from this, and analogous to that of a disturbed and breaking sea, where the green colour of fresh water is also visible. It occurs in cascades, sometimes in the fall itself, at others in the pool below; and is perfectly understood by artists in landscape painting, who in representing these objects are compelled to use a green tint to give truth to their colouring. In these instances, the body of air intervening between the fall and the rock, or mixed with the water below, serves to cut off the transmitted colour of the rocks, and thus allows the water to display its natural tint, in a greater or less degree, according to the varying circum-

stances that attend the cascade. The fall of Scaffhausen has long been celebrated for its green water, but the colour is common to all clear waters under similar circumstances.

Green is therefore the natural colour of fresh as it is of sea water; displaying itself whenever the circumstances are the same in both, and only more rarely observed because more rarely free from obstructing impediments.

I cannot however quit this subject without noticing an hypothesis respecting the cause of the green colour, which seems groundless. It has been said that as the colour of the atmosphere is blue, and as green is not a simple colour, the colour of water must also be blue, and that the green is a result of the mixture of clay or of some yellow tinging substance with its natural blue tint. The first part of the proposition does not appear in any respect to present a legitimate inference; as it it not at all necessary that because vapour reflects a simple colour, water should not reflect or transmit a compound one; if it were even certain that green is necessarily compounded of blue and yellow rays. With respect to the latter opinion, there is not the slightest ground for supposing that any yellow substance is held in solution in water, either fresh or salt; and it is equally impossible that yellow clay should be held in a state of suspension in water, in sufficient quantity to give it colour at the depth of a few feet, or at any depth, without destroying its transparency. It is almost superfluous to add that yellow clay is a rare substance, and assuredly it is not dispersed through the whole mass of the ocean.

There is an exception to the proposition here maintained respecting the green colour of water, but it is a solitary one. This is the blue colour of the Rhone as it issues from the lake of Geneva. It has long been known, but has unaccountably remained without even an attempt towards a rational investigation. Even the accompanying circumstances which might afford ground

for conjecture to those who have not themselves had an opportunity of examining it, remain unrecorded. It is to be hoped that they will not remain so for ever.

THE altitude of the mountains of Arran, and its position in respect to the high lands to the eastward, render the climate peculiarly rainy; from which cause the rivers of this island are both more numerous and permanent than we should be led from its magnitude to expect. Still, they are small streams, yet their courses, and more particularly their estuaries, are often marked by considerable deposits of alluvial matter.

The most conspicuous of these constitutes a sort of delta in Brodick bay; forming a considerable tract of flat land, apparently gained from the sea by a gradually accumulating deposition, which, even yet, is shallowing the bottom of the bay and throwing up bars to the impediment of its navigation. The streams running from Glen Rossie, Glen Shira, and Glen Cloy, contribute jointly to the formation of this plain, which seems to have been derived solely from the action of the waters that descend from the neighbouring mountains, and to be constituted of their ruins. The waters of the Sannox glen have also brought down from above, considerable quantities of matter. But the shore being here open, and unprotected from the current of the tide and wash of the waves, no plain has been formed. A gravel bank is the only result; its progress and increase being prevented by the sea, which distributes the materials along the shore, or washes them out into greater depths. Loch Ransa, of which the depth and shelter, moderate or check the action of the sea, has afforded a place for the lodgment of these transported substances, by which the size of this bay has been materially diminished, and is doubtless still in a state of diminution. The castle is built on a bank of this alluvium; long since consolidated, and forming a

bar, which, by stretching nearly across the bay, affords an excellent inner harbour for boats, where they lie, as in a pond, protected from sea and wind.

The alluvia in Glen Catcol present a different appearance. These form terraces skirting the borders of the river, which seems now to be working its way through materials which it has at some former period deposited; a phenomenon sufficiently common in the mountain torrents of Scotland. Similar terraces are found occupying the narrow mountain glen through which the Iorsa runs, but they are here of considerable extent and depth; much greater indeed than to permit us to attribute their formation to the feeble stream which is now employed in undermining them, and in carrying their materials forwards towards the sea. The origin of such alluvia, extremely common in the continental land of Scotland, is indeed very obscure. A few perhaps may have been deposited in particular situations by the same waters which, under certain progressive changes, are now removing what they formerly laid down; while, in other cases, it is impossible to assign any mode of action by which this double and opposite effect could have taken place from one agent. In some of these situations, the lateral descent of materials at right angles to the course of the valley and of the main stream, seems to have produced these accumulations; which the action of that stream is daily employed in shaping into the forms so often witnessed in narrow mountain valleys, and so conspicuous near the course of the Iorsa. In other cases the quantity and quality of the materials, their extremely rounded forms, the nature and permanence of the hills above, and the want of a regular gradation of size in the stones from the bottom upwards, seem to show that other causes, of a transient, and probably of a diluvian nature, have in distant times generated those deposits, which have been subsequently acted on by the stream concentrated on the bottom of the glens by the form of the ground. A wide

open valley, forming by far the most considerable extent of flat land in the island, accompanies the courses of the Blackwater and the Machrie. Nearly the whole of this tract is alluvial, consisting of sand, clay, and gravel; and although hitherto almost neglected, it will probably in no long time, and in the gradual progress of improvement, form the principal agricultural district of Arran. So great is the extent of this valley and so few the waters which have their courses through it, that the origin of its alluvial materials can scarcely be assigned to their action. It is more probable that, like the former, these have been the result of diluvian causes.

The course of the Sliddery through a deep and very narrow glen, is also marked by alluvial terraces. But the origin of these, appears to be in the gradual destruction and descent of the surfaces of the hills which bound that glen and are composed chiefly of a tender red sandstone. As far as I could discover the nature of these terraces by examining those which were broken, they seemed composed of the materials immediately at hand, bearing no great marks of violence, or of distant transportation. It is unnecessary to notice the deposits of minor extent which accompany the smaller streams, since they all concur in pointing out the same cause, namely, the hourly action of running water on the surface. They are amply illustrated by the banks which skirt the rivers descending from Glen Rossie and Glen Cloy, and of which the ulterior transportation has formed the plain of Brodick already described.

Other alluvia, less easy to explain, are to be found occupying the summits of low hills and extending over considerable tracts. The most remarkable of these reaches from Corryravie to the Bennan head; forming a range of hills, of which the bases and more solid parts are the sandstone strata that will be described hereafter. The alluvial matter here, consists indeed of little else than the sandstone and the red clay which would result from

the decomposition of the secondary strata beneath; interspersed with occasional fragments of the syenitic and trap rocks which lie higher up in the island. Except these rare fragments, they bear no marks of foreign or distant transportation. There are no traces of water courses to account for their present position and depth, nor do the form and situation of this range of land, skirting a wide and open sea, or the other circumstances in the condition of Arran, render it probable that they were deposited by diluvian causes. Parallel circumstances however occur in the neighbouring peninsula of Cantyre, which throw light on the subject; while they also present a series of facts interesting in another manner, as serving to establish a connexion once more general among the several tracts of sandstone visible in these islands and on the adjoining continental shores. On many parts of this peninsula, portions of red sandstone are to be seen detached from those immediately adjoining, occasionally insulated at a great distance from any similar rock, and occupying very minute spaces. Independently of these fragments of sandstone strata, alluvial deposits of a red colour are also found in the same tract; being most numerous in the neighbourhood of Campeltown, whence they extend interruptedly to the north of the alluvial plain which lies near that town, and along the western shore as far as Tyanloan.

These alluvia all consist of red clay and sand with occasional fragments of red sandstone interspersed, and they are disposed in the form of detached banks or low hillocks, insulated from the surrounding land, and easily distinguished by their outlines. They vary in depth from four or five feet to sixty or seventy; opportunities for examining their sections occurring in many places where they are cut through by the streams from the hills. Where these sections are sufficiently deep, it is evident that they lie on masses of red sandstone; and in searching for the common line of separation, it is also perceptible that there

is a gradual transition from the solid rock to the loose clay; the fragments of the former diminishing in size and number till they vanish in the mass of rubbish and red earth. Where the sandstone strata are more solid, and reach the surface, they also present the same tendency to gradual decomposition, being covered with thinner and more partial deposits of the same alluvial matter. It is easy therefore to perceive in Cantyre that which is less obvious in Arran; that the alluvia in question are untransported materials formed in their present places by the destruction of subjacent beds of sandstone; and thus the alluvial tract of Coryravie admits of an easy explanation.

Alluvial deposits, of small extent, but of similar characters, are found in other parts of the island; but it is unnecessary to describe them, since they offer no particular interest either in a topographical or scientific view.

Besides these alluvia, of general occurrence everywhere, Arran displays alluvial deposits of somewhat distinct characters. The first of these, although common on many of our shores, is so rare in the islands described in this work, as to render it an object worthy of notice. This consists of a bed of pebbles skirting the greater part of the coasts, often to a considerable extent, and having by a gradual accumulation, repelled the sea from the solid materials of the island, which have once apparently been washed by it. It is very remarkable between Loch Ransa and the mouth of the Iorsa, as also from Loch Ransa to Lamlash bay; throughout the greater part of which extensive tracts, it is covered with grass and converted to the purposes of pasturage and agriculture. It occurs also conspicuously on the southern shore, and, with few exceptions, may indeed be considered as forming a belt round the island. Independently of its agricultural value, it furnishes a level road of communication throughout the greater part of the country, and is the more striking,

from the contrast which it presents to the almost invariably rapid rise of the land that constitutes the body of the island. It offers a curious and interesting record of the changes which have been gradually taking place in the form and disposition of the land; and, to those who are pleased with speculations on futurity, may perhaps present the additional gratification of enabling them to look forward to a period when the destruction of the mountains shall be accomplished, and the whole of the island shall subside into one widely extended and level plain. Partial accumulations of this nature are not rare, but no instance has occurred in my experience on this coast, of any so complete, so uniform, and so equally distributed. The causes may be sought in the great evenness of the coast of Arran and in its freedom from indentation; as well as in the equal action of the tides and waves round it, and in the regular and small force which they exert upon the shores. The progress of this accumulation may be traced by comparing various points of the coast; and the earliest traces are most visible between the Sliddery and the Bennan head. Here, wide shores of pebbles are to be seen, once rounded by the action of the waves, but now overgrown with lichens; while the sea, repelled to a distance by the increasing accumulation, is exerting its power on materials more remote, destined, in the same way, to repel it still further from the mass of the island. Nearer to the land, the clay and sand which fill the interstices of the more ancient pebbles, give root to the maritime plants, the Artemisia, Matricaria, Ligusticum, and the beautiful Pulmonaria maritima; which, decomposing in their turn, form the soil that in the end becomes a smooth and grassy plain.

Another alluvium of peculiar character occurs on the eastern side of Ben vearan, high up on the slope, and indeed not far beneath the summit of the mountain. It presents a deep coat of irregular materials, consisting

of a mixture of clay, sand, gravel, and fragments of granite. These descend by degrees along the face of the hill, and are deposited in the higher parts of the valley, which is here the upper end of Glen Catcol. If these materials are examined, they will be found to consist solely of the granite of the hill itself, which is readily distinguished among the other varieties the island affords, by its small grained structure. As no streams descend along this face of the hill, it is obvious that these alluvia are the result of the gradual action of the ordinary atmospheric causes on the bare rocks of the summit; their gravity, aided perhaps by the gradual and constant drainage of the surface waters, urging them downwards till they repose at length on the more gentle declivity of the valley beneath, to be succeeded by fresh waste and fresh deposits on the higher grounds above. The alluvia of the valley are here therefore neither the result of the daily action of torrents nor of remote diluvian causes; and this fact may be extended analogically to many of the Highland valleys, where the real origin of those deposits is rendered more doubtful from the similarity of the rocks over large tracts of country, and where they have been frequently attributed to the causes last mentioned. The identity and the peculiarity of the materials, are here sufficient indications of their true origin; and the fact itself is of importance in examining the nature of alluvial deposits for the purpose of inquiring into the nature and causes of those very obscure phenomena which seem to record the former action of large bodies of water on the earth's surface.

The last alluvial substances worthy of being remarked in Arran, are the blocks of granite which are found almost every where dispersed over the island. These are of various sizes, and often of an enormous bulk. Among the great numbers which exist, I observed none bearing the marks of a distant origin; all of them, wherever found, having the characters of the granites of the adjoin-

ing mountains; characters sufficiently distinct from that of almost all the granites of Scotland. These blocks are not only largest, but most numerous, in the immediate vicinity of the mountains, and become smaller and less frequent towards the remoter parts of the island; I may here add, that they are also found on the shores of Lamlash. One block of an enormous size, among many others of considerable dimensions, is to be seen near Corry; and in this neighbourhood they are indeed abundant, while at the same time their origin in the mountains above is sufficiently obvious: as we recede from these it becomes more difficult to trace their progress. Some also, of great bulk, lie on the shore under Corygills, in such situations that a spectator examining the surface of the now intermediate land, would be unable to assign any possible road for their descent from their original to their present position. This difficulty increases still more when we view them in a situation so perfectly insulated as Lamlash island; or on the southern summits of the lower hills, now separated from the mountains by an intricate series of deep valleys. This phenomenon has already often excited the attention and called forth the ingenuity of philosophers; but no situation has perhaps been pointed out where the origin of the travelled blocks is more obvious, or their new position more difficult to comprehend, without assuming considerable revolutions of the surface of the land over which they have passed. But I can add nothing to that which is, on this subject, already familiar to geologists. It is sufficient to have pointed out one example, in which the compact and solitary position of the fixed mass of granite, the identity of the materials of this mass with that of the travelled stones, the gradual diminution of these as they recede from their parent, and the insulated position of the whole, render their origin indubitable, and present to the geologist a spot, on the changes of which

he may speculate, with the certainty that he has before him a set of incontrovertible data from which to reason.

Before entering on the details and geological connexions of the particular substances which enter into the structure of Arran, it will conduce much to perspicuity to give a general topographic sketch of their positions. The perpetual transference of the attention from the geological to the geographical places of the rocks, tends otherwise to produce a confusion both in the description and in the reader's ideas, since these different relations are often very discordant.

The* greater part of the shores of this island may be considered as formed of red sandstone. This rock is, to an unphilosophical eye, the lowest, and maintains the same apparent position both in the northern and the southern divisions. The geologist alone assigns its true place, and proves that in the former tract it is superior, in the latter inferior, to the more elevated interior rocks by which it is accompanied. This sandstone is tolerably continuous from Brodick to Kildonan castle, where it is obscured or displaced by a body of trap, and it is found to reach to a considerable distance in the interior of the island. It re-appears, covered only with alluvial matter, between Kildonan and Sliddery, where it is again lost, giving way to a range of porphyry that extends as far as Blackwater. Here the strata recur a third time, alternating (topographically speaking) with claystone and porphyry as far as Drumodoon, when they become more continuous, extending to Tormore. At this place, the occurrence of a considerable alluvial tract prevents the fundamental rock from being discovered, but beyond

* Plate XXII. fig. 3. This section, it must be remarked, is merely intended to convey an abstract idea of the relations, not a picture of the proportions or situations of the rocks.

Machrie, the sandstone once more appears, extending to the Iorsa river where it terminates. It is not to be seen from hence until we arrive at Loch Ransa; beyond which it occurs again, accompanied by various other secondary rocks and continued in an uninterrupted manner to Brodick, the point from which this description commenced. As the Machrie rises from the east shoulder of Ben huish and not far from the eastern shore, it will be found to separate the whole of the sandstone, together with the trap, from the granite and schist; with the exception of the narrow line of the former that skirts the shore from Brodick to near Loch Ransa.

The rocks which form the next most conspicuous tract on the shore, are of a schistose nature and of various composition; and they are found along the whole line from the Iorsa to Loch Ransa. To the north of this place they retire within the outer belt of sandstone, occupying a narrow space between that rock and the granite in some parts, and, in others, intruding into several of the valleys which descend from the high mountain group of the northern division of the island. But they are not found beyond Brodick on the eastern, nor the Iorsa on the western side; a tolerably decided mineralogical line being here drawn between the two divisions of the island; and the sandstone only, or latest stratified rock, being common to both. The lofty summits of the northern division consist entirely of granite; which, to whatever unknown depths it may extend, rarely occupies the valleys or lower skirts of these mountains, which are formed either of the schists, or of the sandstone strata already described.

It is difficult to give any accurate idea of the districts occupied by the several kinds of rock which constitute all that part of the southern division of the island which is not sandstone. The gently rounded forms, or flat surfaces of these hills, are so favourable to the accumulation of soil, and that soil is so concealed by deep

tracts of peat and the luxuriant growth of heath and other moor plants, that the rocks are seldom accessible. In general it is not difficult to determine the extent of many kinds of rock, from the mere comparison of remote and occasionally protruding masses. With regard to the secondary strata, or the stratified rocks in general, that determination is commonly easy; from the experienced continuity and regularity of these substances in other situations where they are accessible. But in the rocks which are not stratified, and more particularly in that class which constitutes this part of Arran, no such rules can be relied on; as they are notoriously subject to interruptions, and to be intermingled with the secondary and stratified rocks with which they are associated. Where more than one species of this family occurs, the determination becomes still more intricate, and seems indeed to defy all powers of conjecture or comparison. This is the case with the tract in question, where many different rocks of this nature are found; all possessing the common character of being connected with the stratified substances, in a position sometimes inferior, in others superior to them. In such circumstances, even a map is unavailing for the explanation; since points alone can be marked, and even these can scarcely pretend to accuracy of position unless a geometrical survey were made for that especial end; a labour which would not be repaid by any corresponding advantages, either in geological science or topographic mineralogy. I must refer the reader to the accompanying sketch of a map; and need only here add, that the rocks which constitute all those parts of this division which are not sandstone, are varieties of trap, syenite, porphyry, and other rocks of this family, the peculiarities of which must be considered in the mineralogical details hereafter to follow.

In describing the rocks of this island according to their more minute geological details, I shall take

them as nearly as possible, in the order of their superposition.

Granite occupies the highest parts as well as the largest proportion of the mountains of the northern district. In general character and aspect, it resembles in some places the well known granite of Cornwall, with which it also corresponds occasionally in mineral structure. It is often disposed in prismatic and cuboidal forms, or rather, may be considered as a solid and extended body split into masses of such configuration. When these are of considerable size, and of small dimension in one direction compared with that in the two others, they put on the appearance of beds; a circumstance very conspicuous in Glen Sannox, and which, in more instances than this, has given rise to a belief in the stratified disposition of granite. But there is no continuity in these beds, and they are placed in so many different directions, even within a very small space, while at the same time they show no marks of fracture, or incurvation, that it is impossible to contemplate them for a moment without abandoning this opinion. The occurrence of stratification in rocks is a feature so common, that it is not surprising if every structure bearing a resemblance to that which it produces, has been considered as marking a similar origin. A more extensive view of these subjects, and some attention to the magnitude of the scale on which Nature operates, will lead to analogies explanatory of these appearances. These may be found in the foliated disposition of schist, which seems the result of a process somewhat analogous to crystallization, or, to speak more correctly, is one of the various modifications of the concretionary structure. Similar appearances are not uncommon among the other unstratified substances, namely, porphyry, syenite, and the various other rocks of the trap family:* as I have noticed in the account of the hypersthene rock of Sky, and on other occasions. It would in itself be sufficient evidence against the

stratification of the granite of Arran, to point out its connexion with the superincumbent schists. This has been brought to light at Loch Ransa in a most distinct manner, by the removal of the soil where the junction of these substances takes place. In numerous other situations in Scotland, it can be seen already exposed to view; insomuch that no rational doubt can be entertained respecting the true nature of a phenomenon so very palpable and so frequent. As a fact proved, it may also be considered a rule, not an exception. The ramifications which proceed from the mass of granite into the schist at the place above mentioned, are numerous and intricate, and they diminish as they recede from the main body; while their mineral character undergoes a change; the granular structure becoming more minute, almost in proportion to the minuteness of the vein, until the true character of granite entirely disappears. It is superfluous to repeat the conclusions which have been drawn from these appearances, relative to the origin of granite, since they must be familiar to every one.

The prismatic forms visible in Goatfell and in many of the neighbouring summits, are by no means an universal feature of the granite of Arran. In many places it presents solid and continuous faces of rock; while, in others, it offers a sort of irregularly laminated structure, very much resembling that which occurs in certain rocks of the trap family, including the syenites, and porphyries. But there is a modification of this structure in some of these granites which is deserving of more particular notice; as well from its rarity as from the resemblance it possesses to that of some of the porphyries of the same island. It will also tend in some measure to illustrate the views already held out respecting the occasional pseudo-stratified appearance of this rock.

The fine grained granite found on the western side of the granitic district, forms the entire mass of Ben huish, Ben vearan, and some other hills, occupying, in conse-

quence, the Glen of Catcol as well as the other neighbouring valleys. It is in the upper part of this valley that the structure in question is most conspicuous. Here the rock is occasionally prismatic, and on a much more minute scale than as it occurs under that form in Caime na caillich and other places on the eastern side of the mountains; since the prisms, which present a varying number of angles, frequently do not exceed a few inches in diameter. It is also much more often schistose. The laminæ into which it exfoliates, vary in thickness, but may be found so thin as not to exceed the tenth of an inch; while they may sometimes be raised in succession, and of considerable dimensions, from the same surface of a solid mass; indicating that the whole will hereafter, under exposure of sufficient duration, be resolved into similar forms. This schistose structure is irregularly interspersed together with the prismatic, and, in some rare instances, they will be found united in the same block; a circumstance, as will hereafter be shown, of frequent occurrence in the porphyry of this island.

With respect to the composition of this granite I must remark, that it contains but occasional scales of black mica, and that it is principally composed of an intimate and minute admixture of quartz and felspar, with small crystals of hornblende sparingly dispersed throughout. It is consequently of a very light grey colour. The schistose structure therefore, depends in no wise on the mica, and presents no analogy to that of gneiss; the rock being perfectly and equally granular throughout, in a degree indeed equal to that of many sandstones. Nor, when the exfoliation has taken place, do the surfaces show any marks of decomposition; the natural freshness of the rock remaining nearly such as it would be after a forcible fracture. I may add, that the blocks which seem likely to undergo this change, and even those in which it has actually commenced, show no symptoms of future and similar exfoliation; and that all mechanical attempts to

produce a new, or prolong an old fissure, are unavailing; the rock breaking before the wedge or chisel in the ordinary and irregular manner.

The occasional schistose structure of granite has been remarked by foreign geologists, although it seems to have excited no particular attention. As before suggested, it may possibly tend to illustrate the question respecting the stratification of granite, concerning which some remarks have already been offered.

In Glen Sannox, (to select that as the most conspicuous example,) the rock extends in large thick plates only, incapable of a more minute schistose division, if we may judge so from the absence of specimens similar to those now described. But in Glen Catcol it presents the same thickly laminar disposition, descending, in a gradual manner, through a thinner laminated, down to a schistose structure. Here then is a regular gradation of that, which, through all its variations, must be considered as an example of the concretionary structure; and it confirms the opinion before held out, that the extended and flat beds of granite, wherever they may occur, are of an analogous nature, and unconnected with the laws that produce stratification. With regard however to the schistose exfoliation of granite, there is another explanation to be offered, which will more properly be considered at a future opportunity. But it does not apparently affect this argument; since, even if the schistose specimens of Glen Catcol be admitted to have proceeded from the species of exfoliation here alluded to, the gradual diminution in thickness of those laminæ which are not schistose, and the want of that persistence and regularity of disposition which attends real strata, leave it in its original force.

The mineral characters of the granites of Arran are in most cases different from those which prevail throughout the greater number of these rocks in other parts of Scotland. But it is useless to attempt a description of

the numerous varieties which this substance presents; it will be sufficient to notice the most remarkable. Some of these are mixtures of the three most common ingredients, quartz, felspar, and mica, while others are characterized by the presence of hornblende. One of the most remarkable peculiarities which it displays, is a tendency to decompose in crusts parallel to a central mass; a phenomenon common in the trap rocks, and which has been supposed to indicate similar circumstances in the origin of both. Another peculiarity may also be occasionally seen in the granite of this island, namely, a circular distribution of the mica. This sometimes occurs in granite veins, and is connected with a considerable number of appearances in rocks, the most remarkable instance of which is found in the orbicular granite of Corsica. A similar distribution is to be seen in some parts of the Serpentine of Anglesea.

The texture of the granite of Arran is sometimes coarse, at others fine; the latter variety occupying the western side of the island, while the former is limited to the eastern: it is unnecessary to draw a more accurate line. In some cases the coarse varieties contain distinct crystals of felspar imbedded in the more regular granitic basis; an appearance common in the granite of Cornwall, and from which this variety has been termed porphyritic. This granite, of whatever texture, is generally grey, the felspar being whitish and the mica black: but a red variety occurs in small quantity on the north side of Glen Sannox. In some cases the general grey mass is stained with yellowish brown, and blackish spots, commonly very distinct, and producing a peculiar effect. This stain seems to be foreign to the rock, and chiefly to pervade the felspar; yet it does not seem the effect of any oxydation of a metallic matter, as it is found in the central parts of fresh fragments. It has the appearance often given by manganese to sandstones. Another peculiarity is not unfrequent in the granite of Arran, namely,

the existence of cavities in which both the felspar and quartz are crystallized at liberty, although of but small size: more rarely the mica is also found in similar circumstances. The felspar is in these cases whitish and ill defined, and the quartz is generally brown and transparent; presenting its most common regular shape, the hexagonal prism with the terminating pyramid. I formerly mentioned in treating of St. Kilda, that the syenite of that island, which is decidedly associated with trap, and therefore of a posterior origin to granite, is marked by the same peculiarities; affording an instance, among many others, of the great affinity which is often found to exist between certain rocks of the primary, and others of the secondary division. Another variety of this granite is remarkable for containing two kinds of felspar, the one of an earthy and dry aspect, as if from the loss of its water, the other of the glassy kind. This appearance, as will hereafter be seen, is very remarkable in some of the porphyries which constitute so peculiar a feature in Arran. The last variety which I shall notice, contains blueish felspar. It is unnecessary to describe the remaining aspects which were observed, since the description of such varieties is scarcely intelligible without the specimens, and affords no instruction.

With respect to the granite veins of this island, it may be remarked that graphic granite is found in detached pieces, but I know not that any one has observed it *in situ*, as the public is not in possession of the observations which have been made by the numerous geologists who have visited this spot. It is probable that here, as elsewhere, it is the produce of veins; and that these are independent, and of a different nature from the root-like veins to be seen at the junction of the granite and schist, as well as from those which traverse the granite itself.

These latter are frequent, and seem always to have their origin and termination in the rock which contains them. It is impossible to prove that this supposition

is universally true, but it is highly probable, as they have frequently been observed to terminate in the granite, and never as yet to pass beyond it; a circumstance in which they resemble the veins occurring in other rocks, commonly, if not always properly, called contemporaneous. Among other places, they occur in Goatfell. They are characterized by the smallness of their grain compared to that of the surrounding rock, as well as by a frequent want of distinctness in the constituent parts; while their sides are often amalgamated with the including substance. Akin to these veins, there occur distinct concretions of similar fine grained granite imbedded in the ordinary kind, and equally resembling the veins, in the intermixture of character which takes place at the points where they join the including mass. This however is an appearance by no means uncommon in granite, and it is particularly frequent in that which extends from Glenco to Rannoch; where, as in other places, it seems to form but one modification of that very frequent change of crystallization, as well as of aspect, and proportion of ingredients, which is so frequent in this rock. The cause of its concretionary form must for the present remain unknown to us, but such concretions are not peculiar to this substance. They occur in the rocks of the trap family; and Arran itself produces some striking examples of this nature. Another view may be taken of the origin of these concretions in granite, as well as in trap. They may be supposed analogous to the imbedded fragments in conglomerate rocks; and thus a large grained granite containing masses of a smaller grained variety, may be esteemed a granitic conglomerate; a substance not more unlikely to occur than that, of which the examples seem sufficiently unequivocal, namely, a conglomerate in which a paste of granite contains fragments of micaceous schist.*

* I pointed out long ago in the Transactions of the Geological Society, the magnetic property of the granite of Goatfell, and have since confirmed the frequency of this phenomenon from observations made on Cruachan,

As, in describing the syenite of Sky, I took occasion to point out its occasional identity in point of mineral structure, with those granites which occur beneath the primary strata, and also referred to a fuller consideration in this place, some peculiarities in the syenite of St. Kilda, I shall terminate these remarks with a nearer approximation of these facts to those which are visible in this island.

There is a very strong resemblance between the granitic syenite of Sky and many portions of the small grained varieties of granite that are found in Glen Catcol; nor indeed is it easy at times to distinguish them, when in hand specimens. The same striking resemblance exists between the larger grained syenite of St. Kilda and some parts of the granite of Goatfell; while the resemblance here is rendered more striking by the identity of the cavities in both, and by that of the crystallized substances, the felspar and quartz, which they both contain. It is also remarkable that in both, the quartz is smoke coloured, or black, and if Martin's report is trustworthy, the magnitude of the crystals in St. Kilda is equal to that which they attain in Arran.* In neither case have geologists entertained any doubts respecting the geological connexions of these different rocks; the syenite of Sky lying decidedly over the secondary strata while that of St. Kilda is continuous with trap; and the granites of Arran, without any exception, being covered by primary schists and successively by the red sandstone. These circumstances will perhaps only be regarded as striking examples

on the mountains of Mar and Atholl, and more recently in Mull; but as this subject was then sufficiently discussed, it is unnecessary to take further notice of it here.

* I must here also add, that I am informed by Mr. Von Buch that the overlying granite which he has described in his work on Norway, resembles precisely that now under review, containing similar cavities; and there is no doubt that his rock is connected with the porphyry, and consequently appertains to the syenite of the overlying rocks.

of the resemblance between two rocks which seem to differ widely in the respective periods of their formation; although even that might admit of a doubt among those who consider granite, as well as syenite and trap, to have been protruded from below in a state of fusion. Whether or not there be any foundation for such doubts, or whether any obscurity actually hangs over the geological relations of the granite of this island, the question can only be with propriety examined after the stratified rocks which lie above it have been described; and to that period I shall therefore refer the very little I have to offer on the subject.

THE next rock to the granite in order of superposition, is the schist.*

* I have taken one general term for the whole of this tract of rock, although presenting many varieties or species. When geological facts are to be described, it is often necessary to use terms of a general nature, as it is otherwise impossible to preserve a luminous order of description; the frequent interchange of mineralogical names leading to confusion, and often to misapprehension. Such terms should be viewed as geological, and they are thus distinguished from mineralogical appellations; which are as much required when substances are to be specified, as they are inconvenient when the general structure of a district is described, or when geological theories are discussed.

There are still stronger cases where the necessity of using general terms of this nature for the purpose of geological reasoning is apparent. Granite for example, is distinguished by mineralogists into granite and syenite. In examining the geological connexions between a body of granite and any neighbouring rock, it cannot affect the reasonings whether, at a particular point, hornblende is found to be an ingredient in that granite or not. Here the interchange of the two terms will produce confusion, perhaps error; which, in this particular case, may be considerable, since the mineralogical term syenite, implying the variety of granite above alluded to, is also applied to the leading member of a subdivision of rocks superior to, or more recent than the stratified rocks, while granite is inferior to these. Similar confusion may occur in other cases from a similar practice; or rather, from omitting to specify whether the terms used are general or particular; often perhaps from the observer neglecting to investigate the connexions of the rocks which he is describ-

The region occupied by this class of rocks has already been pointed out in a general way, and may be deduced from the coloured map; although its limits cannot be very accurately defined, from the imperfect nature of the maps of Arran hitherto published.

It would be superfluous to enumerate the places where the schist occurs, or where its boundaries are visible; as the list would be merely a tiresome record of names, and as, for want of a sufficient number of these, many places must still pass unnoticed: it will be sufficient to indicate the former in a general manner, and the latter where any remarkable appearances are visible.

The most extensive and continuous mass is to be seen between Loch Ransa and the mouth of the Iorsa. It here occupies the whole shore, forming a continued range, sometimes of rocks and low cliffs, at others of more gentle declivities. It may be traced from the shore up the sides of the hills, and along the courses of the

ing, or, from his deducing conclusions from the examination of hand specimens or detached rocks. Thus the term greenstone, appropriated to a member of the trap family, has also been applied to certain varieties of granite. Mineralogically considered, this is sufficiently correct; but it is plain, that unless the geological connexions of these two far distant families of rock be taken into the account, the greatest errors may arise.

The reader must long since have perceived, what perhaps ought to have been distinctly specified at an earlier period, that the term granite has been invariably reserved for that rock which occurs beneath all the strata, and that of syenite for the substance of analogous character which is found above them. In one point of view this distinction is incorrect, but the latter term having been often so used already by geologists, it is to a certain degree justifiable; while, by using it in this manner invariably, all geological ambiguity is avoided. The two distinct and separate grounds on which a nomenclature of rocks ought to be founded for the distinct purposes required, are such, that it is not easy to reconcile them; nor am I prepared to amend that which has so long been a source of difficulty to those of greater experience and knowledge. In the present state of things it is somewhat to be intelligible; an object worth attaining by a small sacrifice of logical arrangement.

waters of Ransa and Catcol, as well as those of the Iorsa, to a considerable distance, until it is superseded by the granite. Although the regions where the one rock ends and the other commences, can generally be determined within a certain limit, the actual junctions are rarely visible, owing to the incumbrance of soil and plants. In very dry seasons, and with care, some of these points might possibly be found in those torrents where the rock is laid bare: but even in these places, the view is often obstructed by the blocks of granite which accumulate in the beds of the streams and conceal the junctions. The actual junction is however visible near Loch Ransa, but it was already mentioned in speaking of the granite. I shall here only add that it extends from Tor nion, where it has been laid bare, across the opposite ridge into Glen Catcol; during the whole of which course it is occasionally visible.

The position of the beds of schist with respect to the granite, can also be determined with certainty in many parts of this junction, and they may in general be said to recline against it: yet if, in other cases, a given bed of schist be prolonged towards that rock, according to its position in any one place, it will be found to indicate the contact of the edges instead of the faces; while, in tracing the linear direction of the strata in a third set, they will tend to abut endwise against the mass of granite. But as in examining the positions of the schistose beds in various places, they are found to be discordant and irregular with regard to each other, no general rule respecting their prolongation or mutual relation can be established; and it is therefore equally impossible to assign their relations to the granite in a more accurate manner. No general conclusion can therefore be drawn with respect to this connexion, from the appearances any where observed; since even the slight kind of conformity visible at one point of junction, may not be continued perhaps

for ten yards. It will be a question for future consideration, whether this irregularity, either in the contacts of the two classes of rock, or in the positions of the schistose beds separately considered, do not bespeak a common relation of the granite to the whole deposit; namely, that of intrusion at a time posterior to the original stratification.

To the north of Loch Ransa, the position of the schistose beds is for a small space very regular, and their protruding edges can readily be examined on the shore, while the angle of their dip may also be ascertained. But although this angle is, from the causes just assigned, of no use in tracing the continuity or relation of these rocks, it here serves to discriminate the schistose from the secondary strata which lie above them; the example now under review, which is well known to all those who have visited Arran, presenting a very well marked instance of that position which is called unconformable. Neither the position of the one set of rocks nor of the other is so regular as to permit any great nicety of admeasurement, were such nicety of use; but at the point which I examined, the dip of the schistose strata is about forty degrees S. S. E. and that of the secondary strata about thirty degrees W. N. W. On other occasions where the connexion between the primary and the secondary strata have come under review, it has been shown that the unconformable position must be considered as accidental; and it will hereafter be seen, that, in Arran also, the secondary strata which are, in the place now under review, unconformable to the schist, are, in another, parallel to it.

At the point last mentioned, the schist retires from the shore to give way to the secondary rocks; which commence at this place, occupying a considerable portion also of the hills that skirt the higher mountain group. But it is still found between these strata and the granite, extending far to the southward and occupying a considerable space; and would doubtless present to an accu-

rate research, other points of junction both with the granite and the secondary rocks, were it necessary to pursue the repetition of similar phenomena.

It will be perceived on inspecting the map, that a discontinuity of the line of schist is indicated between Scriden and Screeb. There is however little doubt that these rocks exist along the greater part, if not the whole, of that line. But the space between the granite and the secondary strata is obviously very narrow; while the state of the superincumbent soil, and the want of precise places of reference, prevent the few points where the schist can be discovered, from being continuously traced or accurately laid down. It appeared expedient to leave this tract a blank, rather than, by indicating that which may not perhaps exist throughout the whole, to divert future geologists from examining those places where, if in any part of Arran, the junction of the granite with the secondary strata will be found.

Among many failures in the attempts to trace whatever junctions might here exist, arising from causes too well known to practical geologists to require enumeration, I succeeded in discovering that of the schist, both with the granite and the sandstone, near Screeb, in a small but nameless torrent which descends from Goatfell. At this place the junction is characterized by veins proceeding from the granite into the schist, similar to those which occur at Loch Ransa. The body of schist is here very thin, as the secondary strata approach to within a few feet of the granite. This spot presents many interesting particulars, and it is much to be regretted that they are so difficult of access, and that the free and tranquil examination of them is impeded by the depth and ruggedness of the fissure, as well as by the incessant falling of the torrent; impediments of such magnitude that no efforts of art can hope to remove them. The position of the schist is somewhat irregular, and in parts vertical; and it is followed

in parallel order by the secondary strata; the same disturbance attending both rocks, and the irregularities of both being equal, and apparently corresponding in their nature. But I must defer the consideration of the share these latter strata take in this interesting place, till I have described them.

From Screeb, the schist continues to be found on the eastern skirts of Goatfell, from which it may be traced uninterruptedly round the western side of the mountains, through Glen Rossie, as well as on the opposite side of the same valley. But here, as well as in most other places where it occurs, it presents nothing interesting; or nothing at least so far different from the appearances already described, as to require a further detail. It would doubtless be possible to multiply the observations on junctions of schist and granite even in this part of the island; but perhaps not without much labour, or the assistance of tools to clear the ground: the expense of mining must in fact be incurred without the reward. The junctions of the rocks just enumerated, are already too well known to require any further investigation; those of the sandstone and the granite (if they really exist) offer the only stimulus to such a search, and perhaps some more fortunate geologist may hereafter find them in the tract already indicated.

From Glen Rossie, the schist is found to extend to the westward across the high land which forms the shoulder of Ben huish and the western declivity of Ben vearan; skirting Loch Huish and the head of Loch Iorsa, and descending to the shore near the mouth of the Iorsa water, to the point whence this topographical sketch commenced. Thus, with the exception of the doubtful narrow tract on the eastern shoulders of the mountains, it forms a belt surrounding the granite and separating that rock from the secondary strata. Between the Machrie and the Iorsa rivers, the common limit of these two sets of strata

are however undefinable; as this valley is deeply covered with alluvial matter so as to prevent any accurate investigation.

In the preceding topographic account, it has been unavoidably necessary to consider all the schistose rocks of this island under one general term; the confusion attending them, no less than their geographical discontinuity of position, and the difficulty of obtaining a free access, from the incumbrance of the investing soil, preventing all attempts to arrange them in that order which has on other occasions been adopted. That confusion and irregularity are however in themselves interesting, since they bespeak circumstances in the constitution of Arran which are of the first importance in its general history; the consideration of which will be advantageously deferred to the conclusion of this subject.

Notwithstanding this intermixture of the various schists, it may be inferred, partly from observations on this island itself, partly from the analogy of the neighbouring island Bute, and of the corresponding parts of the mainland, that there are here portions of two different series of primary strata. One of these is the micaceous schist which forms the adjoining districts of Cantyre and Cowal; the other is the argillaceous schist which follows that rock in the order of superposition and is immediately succeeded by the secondary strata. This series will hereafter be shown to occupy a very extensive tract in Scotland.

As the general topography of the whole has been laid down in the preceding sketch, it would also be desirable to trace that of each of these series; but this is impossible, for the reasons already assigned, and from the following causes. Even where those two sets of strata occur in a linear and undisturbed direction, as they do in Bute and nearly throughout the whole of the mainland, their relative limits are unde-

finable; a considerable series of alternations, or else a perfect gradation, taking place at the conterminous boundary. It must also be remarked, as will hereafter be more fully detailed, that the series of argillaceous schist is formed of many different substances; including graywacké of various aspects, chlorite schist, micaceous schist, and common argillaceous slate. In different parts of the tract which is constituted by this series, these substances also vary in their relative proportions; some of them being occasionally absent, while another becomes predominant. Thus, where it is even most regular in position, its limits can rarely, if ever, be ascertained by mere observation; but must be deduced by a general comparison of bearings, and by the prolongation of some ascertained boundary to another point where the limit may be accessible. But in Arran, no such assistance can be obtained, as the linear position of both the series is destroyed or perverted; while the parts, which from analogy must be judged to have been originally conterminous, now occupy positions wide of each other, or are obscured by the changes of character they have undergone with change of position, or else are inaccessible by reason of their situations in the interior country. The granite will however be found in a great measure to separate the argillaceous series from the micaceous; while those parts where the two must be conjectured to meet, are either invisible to the degree required for ascertaining their mutual boundary, or undergo a confused transition at the probable place of junction, of such a nature and extent as to render that undefinable.

Under this uncertainty, the map will show that the limit in question must exist between two points, the one of which lies between Loch Ransa and Catcol bay, and the other on the southern declivities of Goatfell and of Ben huish. In neither of these places however can that limit be ascertained, and accord-

ingly no attempt to define it is made. But it is still apparent that the series of argillaceous schist occupies the north-eastern side of the mountains, and that of micaceous schist the south-western; and that the line of separation between the two, lies in a south-eastern direction. If, in examining these two regions, it is observed that they do not invariably adhere to the characters by which the two series are elsewhere distinguished, the causes of this irregularity are not difficult to assign. It is in the first place possible that a part of the north-eastern series, or that of the argillaceous schist, may be found on the south-western shoulder of the mountains; a circumstance which would naturally arise from the granite having intruded in an irregular manner along the common boundary; while the same cause may have separated a portion of the south-western series so as to have transferred it to the opposite quarter. It is also to be recollected, with respect to the series of argillaceous schist, that it naturally contains beds of micaceous schist; while here, as in other similar situations, it undergoes various changes of aspect from the influence of the neighbouring granite.

Such is the separate topography, as far as it appears capable of being ascertained, of the two classes of schist which constitute the schistose tract of Arran. Whatever uncertainty may still exist in this respect, is fully accounted for by the circumstances that have been stated; while the general facts are proved to be correct, not only by the analogy already mentioned, but by an examination of the different species of schist which constitute each mass. These will be found in every respect identical with those which occur in the two analogous series on the mainland; subject only to those differences which the preceding statements are fully competent to explain.

The discordant opinions which have been entertained

respecting the schists of Arran, considered as specimens only, will now be seen to have arisen from imperfect views of their geological affinities and position; combin perhaps with some hypothetical notions respecting t characters which ought to exist in those rocks that approximate to granite. Had the two sets of strata above mentioned been studied on the mainland, and the double series been extended, as is here done, to this island, no such confusion would have existed.

In the first series, that of the micaceous schist, which occupies the chief part of the schistose tract on the western side of the mountains, this rock occurs under the usual diversity of aspect, which it would be superfluous to detail after the remarks on this subject formerly made. Occasionally, as in the more regular parts of the series, it also graduates into talcaceous and into chlorite schist. In some places it passes into, or perhaps rather alternates with argillaceous schist, and at these points probably, the obscure boundary, already described, between the micaceous and argillaceous series, exists. In the tract under review, these transitions will be found to occur principally near the source of the Machrie water, where the common limit of the two is indicated in the map.

There is much more variety in the argillaceous series. Near the whole of the junction before described, which extends from Glen eas na birach to Glen Catcol, the schist is argillaceous, but generally of uncommon hardness, and often interlaminated with quartz in such a manner that the argillaceous ingredient is at times nearly excluded. In a few places it presents the more ordinary characters. It is followed by chlorite schist, passing into micaceous and into talcose schists; the whole being so irregularly intermingled that it is impossible to define their several boundaries. All these varieties are, as in Bute, sometimes of a granular, at others of a simple laminar structure; and their general resemblance to the

rocks of that island, will hereafter be very apparent. It is here therefore obvious that the argillaceous schist is nearer to the granite than the micaceous; whereas in other places on the skirts of the mountains, that order is reversed.

About Corry, a coarse graywacké occurs, similar to that which elsewhere accompanies this series, and the same substance will be found in many other places throughout the north-eastern tract; being, like the former, occasionally nearest to the granite, and presenting therefore an anomaly similar to the former; if that may be considered an anomaly which is inconsistent merely with a hypothetical order of succession. In Glen Halimidel, the argillaceous, chloritic, and micaceous schists are so intermixed, that it is impossible to determine which occupies the greatest space near the fundamental rock; and here slate quarries are wrought both in the chloritic and argillaceous varieties. One of these rocks is remarkable, inasmuch as the [illegible] of chlorite schist is found to contain distinct imbe[illegible] fragments of common blue clay slate.

But it is unnecessary to protract these details, as they will necessarily again come under review in the description of Bute.

Having thus finished the local history of the schistose rocks of Arran, it becomes an object of interest to compare them with those of the adjoining tracts to which their analogy was already pointed out. That which is invisible in this island, from the causes already stated, is abundantly obvious elsewhere; while that which is here confused, is also elsewhere regular: it remains to ascertain whether a cause can be assigned for the confusion of that which is obscure, by comparison with the regularity of that which is obvious.

As a full detail of the series of argillaceous schist will unavoidably be required in Bute, where it forms a conspicuous feature, it is only here necessary to say

that it contains all the substances described as found in it in Arran. With the same general characters, it extends through the whole space which it occupies; differing only by the occasional exclusion of some of the substances, or by the varying proportions of the whole. Throughout its course it also follows the micaceous schist, wherever that exists; passing into this series by the same uncertainty of gradation or alternation. It is also followed in immediate superposition by the red sandstone; the strata of that rock being either conformable to it or otherwise, according to the variations of circumstances which it is here unnecessary to consider. The line occupied by this series conforms exactly to the prevailing direction of the strata of the country, namely north-east; and it is thus extended in one belt from the easternmost point of Scotland where it is visible, to Bute; being subjected to no other deviation or irregularity than those slight undulations already often noticed, from which none of the Scottish strata seem exempt. The dip of this series, like that of the micaceous schist which it follows, may, under the same exceptions, be considered as regular, being towards the south-west.

But in examining the strata, both of the argillaceous and of the micaceous series, as they occur in Arran, their contact is found to be interrupted for a certain space by a mass of granite. At the same time, the regularity of the separated portions is destroyed; the parts of each no longer preserving the usual parallel position among themselves, nor the same common linear direction: the common dip, as well as the common direction of each separate series, is in short annihilated. It has already been remarked that such is here the confusion, that these dips cannot be exactly ascertained; yet it is evident on comparing a great number of the several parts, that the predominant tendency of the whole is that of a conformity to the surface of the granite on all sides; or, in other words, that the strata repose

on the mountain mass. It is therefore evident that there can no longer be a common dip between the two series; since the general tendency of the micaceous or south-western, is the reverse of that of the north-eastern, or argillaceous strata. It is also obvious, that the dips can no longer be conformable to the prevailing tendency of the whole line as it occurs in the great tract already mentioned.

With respect to the common direction of the whole schistose mass of Arran, it is evident from the preceding remarks that it can possess none, and therefore admits of no comparison with that of the analogous schists on the mainland. But it was proved that the mutual boundary of the two series was in this island directed from the south-east to the north-west, in an order the reverse of that of the two conterminous and analogous series on the mainland; and by that boundary the change of direction which the whole mass has undergone may therefore be estimated.

Finally it may be remarked, that notwithstanding these differences both in dip and direction, the place geographically occupied by the schist of Arran, lies on the prolongation of the general line of these strata as they traverse Scotland; and thus their identity in general connexion is no less established, than it is by their community of structure, and of relation to the secondary strata.

The only differences therefore to be accounted for, are those in the direction and in the dip. In attempting to explain these it must be remarked, that no granite occurs either among or near these strata in any part of their linear course. In Arran, where it does occur, all regularity disappears. If to have traced a series so singular and so perfectly identified, through so long a space, every where regular where granite does not occur, but losing that regularity where this rock is found, is not deemed sufficient to prove that the granite is the cause of

this irregularity, the solution of these difficulties must be referred to future times.

I MUST now proceed to examine the secondary strata, as the next in order, commencing with that part of the island where the whole series is visible, as being most explanatory of their history.

This part of the island comprises the tract which extends from Loch Ransa to Brodick; or, more accurately speaking, it terminates on the one side at the point already described as that of the junction of the schist with the secondary strata, while at the other it may be conceived to end near Screeb; beyond which, one bed only of sandstone is continued to a distance that, for the present purposes, may be considered as indefinite. The alternations of the various substances which form this deposit of secondary rock, are nearly all contained within these limits. This tract is perhaps the most interesting part of Arran. All the other phenomena which it offers can be seen in many situations, dispersedly at least, if not connected in one place; but it rarely happens that so profound and so clear a section of the secondary strata can be obtained, as that which is here displayed. It will be seen, that the interest does not arise merely from the number of substances visible; since the successions of these might be studied, though with less satisfaction and facility, in many places. Much of it results from the perfect exposure of the continuous edges of the strata, which enables us to study those lateral variations also, of which we seldom meet such clear indications; while the variety of position which they present in different places, leads to important reflections, respecting the causes and nature of the changes by which this has been produced.

To describe in detail the succession of these strata, would be to produce a tiresome catalogue, as little interesting as the section of a coal field; while the reader,

bewildered with the recurrence of angles, substances, and measurements, would rise from the perusal as uninformed as he would from a survey of the shore itself, if he should examine it only as a cabinet of specimens. The interest which it presents is of a more general nature, and to comprehend that justly, it must be contemplated in a very different mode. I shall therefore begin by presenting the general notion as it was deduced from the comparison of the minute portions, and shall consequently describe it in the inverse order to that of the examination from which the deductions were made.*

* I may here venture to suggest to the geologist who may visit Arran, the mode which he should adopt in examining these strata. This consists, conformably to the general plan, in commencing at the lowermost stratum and following the series upwards. For this purpose he must here begin at a central point, and thus pursuing the elevated edges of the strata in both directions, he will more readily discern their connexions than if he had traced them, either on their flat surfaces, or by walking along the shore from one end to the other; in which case one half of the strata will meet him with their edges, while the other will present their surfaces.

As it is impossible to convey a clear notion of this subject without diagrams,* I have added some ideal sections explanatory of the general positions of the strata; these will also save many repetitions and much circumlocution. The different sections must be considered as developing the structure of a conoidal frustum with a concave superficies, consisting of various laminæ; the irregularities being in one of them reduced to the leading and elementary form. Their object, among other things, is, to show the various inclinations of the strata on different parts of the shore, as the foundation of future reasonings. But these are so irregular and unequal, that neither section nor enumeration could render them thoroughly intelligible; although a general notion of this irregularity may be conveyed by a vertical section, which represents their varying curvature as they occupy either the flat shore or the face of the hill, accommodating themselves to the forms of the mountain against which they recline. I need scarcely add that no attention has been paid to the quantity of the inclination, as such details would have required numerous drawings.

* Plate XXV. fig. 1, 2, 3, 4.

In the general description of the island, I have mentioned the picturesque features of an avalanche of rock occurring on the northern shore. That spot is the central point from which this account commences. The name of the place is, I believe, Scriden, but the circumstance now described will furnish a mark less liable to be mistaken. An immense mass, consisting chiefly of red sandstone conglomerate, is here seen reaching to a great height in the hill, and occupying an extensive tract along the shore. Its thickness may be estimated at 800 or 1000 feet; although it should be much less it is an error of no moment. It is impossible for a considerable space to determine whether this mass has any dip or not where it lies on the sea shore, at least if a wide view be taken.* For such a view the spectator is supposed to stand at an indefinite distance in front of this point, and towards the N. E.; the only inclination at present under consideration being that which relates to the strata lying on the shore, and which respects the north-west and south-east points, or those at right angles to the spectator's position. It is evident that the position of the strata against the mountain, will cause a dip towards him in the upper portions, as shown in one of the diagrams; but this does not affect the present question; while it is obvious that these portions also must be affected in the same way as the lower, as far as the form of the high land permits.† If from this place, where there is no dip to either of the points just men-

* It has elsewhere been noticed, and is here important to recollect, that general conclusions can rarely be drawn from partial and nice examinations of the dips of strata. I may indeed add, that the more accuracy the more error; a rule strongly exemplified here, as well as in other places where, from undulations or fractures, they waver in every direction.

† Although the contemplation of the several diagrams will assist the reader's comprehension, nothing short of a model could represent accurately the dispositions of the several strata, or the general form of the mass.

tioned, we proceed southwards towards Sannox, we find the strata on the shore gradually beginning to incline towards the south; first at a small inclination and with an E. N. E. dip; in which position, or nearly, they will be found to lie near North Sannox. If, proceeding still further in the same direction, the dip be examined, it is found gradually to become more southerly; at length assuming an E. S. E. position, to be followed afterwards by strata inclined still more towards the south, as will hereafter be shown.

If from the same assumed neutral point at Scriden, we now proceed northwards, the reverse inclination gradually takes place, and the great conglomerate stratum will be found slowly adopting an inclination towards the north, to be followed ultimately by strata in a W. N. W. position. The bed now described is therefore curved, and is the lowest of a great series of strata which will be found to lie on it in a conformable manner on each side; adapting themselves to its inclinations as far as their outermost boundary on the northern, and for a considerable distance on the southern, from which point they assume new and intricate positions.*

This foundation being laid for the examination of the secondary strata, we are enabled to compare with each

* The directions of the strata are laid down in the map for the purpose of assisting this explanation, and it is therefore unnecessary to specify them in the description. It must however be remarked that they do not pretend to rigid accuracy, being rather intended to illustrate this general view, and to supply the unavoidable defects of the accompanying diagrams. The accessible portions of the bed are indeed far too limited to admit of such observations being correct made by taking averages of the bearings; and the local irregularities a at the same time such, that any examination of a minute nature wou inevitably lead to error if confined, or to doubt if repeated and e tended. The diagrams (Pl. 25. fig. 2, 3.) will show that the upper edges of the strata superincumbent on the central basis at Scriden, are all abruptly broken off at each side, even to the outer surface of the whole mass of beds.

other, those which lie above the lowest bed on each hand; to trace their identity if such exists, or else to decide upon their independent and partial nature. It is from this foundation also that we must attempt to conjecture the mass and depth of the strata, the measurement of which must be derived from the lowest point of that foundation. Without it the whole of them present but a dubious and confused repetition of similar rocks, with little interest and a very uncertain connexion.

The conglomerate which forms the greatest portion of the fundamental mass, is similar to that which accompanies the red sandstone in other situations, in Scotland as well as elsewhere. It is an aggregate of quartz sand and red ochrey clay, with a little mica; together with rounded pebbles and angular masses of different sizes, often attaining a very great magnitude. These consist of clay slate, micaceous schist, graywacké slate, quartz, and pieces of former sandstones. Such at least are the prevalent ingredients; if it contains fragments of other rocks, as is possible, they are neither numerous nor conspicuous; and I must add, that in no instance did I discover a fragment of granite in it. This conglomerate, although apparently the basis of the strata on each side, is not, strictly speaking, the lowest rock; as there is found under it a bed of red sandstone with white stains, similar to that which will hereafter be described, accompanied by a bed of limestone remarkable for containing rounded and angular fragments of quartz; a conglomerate which occurs in other parts of the series that follows. Nothing lower than this is to be seen, nor is there any ground for conjecturing what strata may still lie between it and the schist in this place; since, as will readily be inferred after the mass of strata has been described, the contact of the schist with a given bed in one place, is no criterion of its relative position in any other. In proceeding northward from

this point, it will be found that all the beds which follow, are distinctly superimposed in succession on this rock; their broken edges appearing in a regular series of steps to the junction near Loch Ransa, where they finally disappear, the dips, as before remarked, being northerly.* At the same time, the angle of this inclination varies with a general regularity along the whole line; the inclinations on the shore reaching from ten to twenty degrees, and those on the faces of the hill from fifty to seventy, but being always towards the same quarter. There are nevertheless accidental irregularities, which sometimes occur in the vicinity of trap veins, or arise from other circumstances not apparent; but they do not affect the general conclusion.

The strata that follow next to the conglomerate and red sandstone, consist of a great series of beds of white sandstone, which are to be seen near the farm of Lagg, and of which the collective thickness must exceed 1000 feet. These are succeeded by a very intricate and numerous series of strata of different substances, alternating in a most irregular manner, and occupying a considerable tract. The number and variety of the alternations occurring among these beds are such, that it would be little less wearisome to the reader's than to the writer's patience to detail them: from the minuteness of many of them, the enumeration would amount perhaps to hundreds. At the same time, as they have rarely any great lateral continuity, it is scarcely possible that two observers should agree in the enumeration; the more so that in many cases there is such confusion as to prevent a fair and free examination. I shall therefore forbear to record that which, even if perfect, it would be useless

* To speak strictly, I should say that the dip is to the north, with slight variations, as far as the Cock and a little beyond it, becoming W. N. W. only at the point where the junction of the sandstone with the schist is visible.

to know, and give a general account only of the most remarkable strata.

Among these, the predominant are red sandstone, red conglomerate, white quartz sandstone, calcareous grit, blue limestone, and shales or schistose marles of various colours, brown, black, red, purple, mottled, and grey. The red conglomerate and the sandstone, here as elsewhere, occasionally contain calcareous matter as well as mica. The red sandstone varies in colour from a brown red to a blueish purple, and is characterized by globular or irregular stains of white, often disposed in a very ornamental manner, as well as by white veins. No adequate explanation has, as far as I know, been offered of this very singular but well known appearance; from which this variety has, among some observers, acquired the name of variegated sandstone. That it does not possess those constant geological relations which have been assigned to it, will be readily deduced from the history of this series. Besides this, some of the beds which present an uniformly red colour, are found to possess a globular concretionary structure. That structure is however invisible on a fresh fracture, and is only discovered by the action of the sea, which, exerting an unequal power on its different parts in proportion to their relative hardness, leaves in many cases a botryoidal surface. Chemical examination detects no difference of composition between the globules and the intermediate parts. I may here add, that other modifications of internal structure are discovered in a similar manner. The most remarkable of these varieties is cancellated; the rock wasting until it becomes a honeycombed mass, and the caverns being irregular and separated by thin lamellæ. Analogous to this is the appearance of thin and reticulating veins, found protruding on the surfaces that are exposed to the sea; these being the edges of entangled and crossing laminæ which possess a hardness superior to that of the general rock.

Among the uppermost beds of red sandstone, one is to be found of an argillo-calcareous nature, containing fragments of entrochi, sometimes round, and in other cases oval, as if compressed. These do not appear to have been as yet referred to any species in the still imperfect history we possess of fossil organic remains. It is probable that the bed itself belongs to some of the inferior strata of that limestone which occurs in much greater masses at Corry; its position here being sufficient to justify that conclusion, notwithstanding the obscurity which arises, from the small dimensions of the corresponding strata on the northern side of Scriden, when compared with those to the south of this central and fundamental point.

The limestone varies in different places, but is commonly of a blueish or smoke-grey colour, presenting generally an even and smooth fracture. In one bed I observed shells of which the general outline and features resembled those large terebratulæ which occur at Corry, hereafter to be described; but being unable to detach them, in consequence of the solidity of the rock, they could not be identified. In other places it contains fragments and pebbles of quartz, or of quartz and schist together, forming a compound limestone conglomerate. In one place it is penetrated by minute veins of red sandstone, produced, it is probable, by the intrusion of loose sand into fissures, during the deposition of the sandstone that lies above it.

The shales present an infinite variety, not only in colour, but in thickness, and in position with respect to the other strata. At times they are so overcharged with red oxyde of iron that they must be considered as iron stones, and in some places they even contain distinct nodules of red granular or compact hematite. It is a transition of this nature that forms the beds of that substance which has been called columnar argillaceous iron stone. Portions of three of these are to be seen

near the ruined Salt pans. They are thin, and divided, like some septaria, into polygonal plates, which are however separated by mere fissures, without any intermediate substance. The divisions of one of the beds are rectangular, so that the surface resembles a sort of pavement in parallelograms; those of another are hexagonal, or variously polygonal; both of them presenting the artificial aspect of a brick pavement. In one of these cases the divisions are strongly marked by a sort of concave moulding, parallel and close to the edge of each piece, so as to add much to the artificial appearance of the whole. This substance is here rare, since it only occurs in the place now described, while there are many alternations of the other strata above mentioned.

Nearly in the same place, the coal which was formerly wrought in this island is to be observed. It is said to have occupied three distinct beds, but the ground is at present in such a state that it is not possible to trace them. From the actual appearance of the old workings, which are however exceedingly obscured by water and rubbish, I should rather judge that all the pits had been sunk on the edge of the same bed, which, having a considerable dip, like the rest of the strata in this place, is here turned upwards. Although the bed itself cannot be examined, its position may be deduced from the examination of the surrounding parts, while its nature may be conjectured from the materials which are scattered about in the vicinity. It appears to repose immediately on the red sandstone, and to be followed by a thick series of white calcareous sandstone; these being again succeeded, although at a considerable distance, by a repetition of the red sandstone. The whole are followed very speedily by the schist, that rock being of course subjacent to them; whence we may infer that at the point where it has been wrought, the coal lies at the very edge of the secondary strata. The substances which immediately accompany it, are black argillaceous sandstone, the same rock of a mixed black and white

colour, common shale, arenaceo-micaceous shale, and bituminous shale, either simple, or containing vegetable remains and impressions. These organic substances, from their length and occasionally parallel outline, resemble the leaves and the compressed stems of reeds. Wherever they occur, their substance is always found on fracture to be composed of an extremely brilliant coal. The coal itself, in the larger masses, is also splendent throughout, containing little bitumen, and burning with difficulty unless it be in a considerable body and strongly heated.

Independently of these beds of regularly stratified substances, there are to be seen, and particularly near Lagg, great masses of trap conglomerate, but whether forming regular beds or not, it is difficult to determine. There are also many masses of common porphyritic greenstone, and of fine grained greenstone, or of basalt. Some of these are evidently veins traversing the strata, while others, which must also be veins conformable to them, have the appearance of beds.

The collective thickness of the whole of the series now described, must be enormously great, as it occupies a space of about two miles on the shore. If the angles of inclination were sufficiently constant, a ready estimate of that thickness might be made by computing that side of a right angled triangle which is parallel to the vertical fractures of the strata, the horizontal distance and inclination admitting of measurement. In the actual state of things, only a vague conjecture could be formed. Infinite patience might perhaps succeed in producing a nearer determination by measuring the breadth of each bed; a toil which would not be compensated by the results.

Where these beds cease, they are succeeded by red sandstone, forming a mountain mass not less thick than that which lies below them, and reaching beyond the Cock, where it at length terminates. It is here termed sandstone, as the lowermost mass was called a conglomerate; merely because the fine sandstone is nearly as predo-

minant in this bed as the rubble is in the other. But it is not every where of this character, since the conglomerate occurs in it, and even in considerable quantity; particularly in the vicinity of the Cock.* The conglomerate indeed, both here and elsewhere, alternates in a very irregular manner with the fine sandstone, being sometimes at the bottom, sometimes at the top of a bed; and not unfrequently it happens that the bed which in one place is sandstone, passes laterally in another place into conglomerate. I must remind the reader that as this sandstone continues to dip to the north, it is consequently far removed from the great bed described at Scriden, being separated by all the intervening small strata. An incorrect examination of this shore, would readily lead the spectator to confound these two distant beds together.

Where this great mass ceases, there is no longer any extensive collection of strata found following it, but the fragments or portions of another series commence. These are limited to the shore, being abruptly broken off, and not extending up the mountain like the former. It is at the outer extremity of these that the junction, formerly described when speaking of the schist, is to be seen, and here the secondary strata at length entirely disappear. The lowest bed of this series in immediate contact with the schist, and where it is most readily examined, is a conglomerate limestone containing schist and quartz. This is followed by a sandstone conglomerate, and by red sandstone; but whatever has once existed above these is now wanting. Different substances are however to be seen in other places near this junction, and on the upper side of the last described great sandstone bed; namely, alternations of the red, white, and spotted sandstones; together with schistose marles, or shales, cal-

* This convenient point of reference is not a headland, but a detached block of sandstone sufficiently resembling a fowl to warrant this its nautical denomination.

careous grit, and some varieties of quartzose conglomerates. The whole collective mass of beds here does not perhaps amount to fifty feet in thickness; but it remains as a beacon to show that a succession of small alternating strata, similar to those before described, has also existed in this place. Of their former extent, or of that which may have followed them to a still greater altitude, there is no ground to judge; but every thing serves to mark the destruction as well as the disturbance of the strata on this side of Arran.

It is now necessary to trace these stratified rocks from the great and lowermost mass, towards the south; a general idea having already been given of their directions, and of their relations to that fundamental point. Proceeding southwards from Scriden towards Sannox, different alternations of red sandstone and conglomerate occur, succeeded at length by white sandstone. All these beds are visible on the shore, and extend at the same time to a great height in the hill. Their dip is, as already pointed out, in the reverse order to those on the north side of Scriden, and the variation in the quantity of that dip is similar; the beds appearing to bend, with their convexity towards the hill, or the angle of inclination being greater above than below. The order of their succession upwards is equally evident; since the broken edges occur in the progress southwards, precisely as they did before in the progress northwards.

At this point in the investigation of the shore, it is necessary to diverge into Glen Sannox, for the purpose of pointing out some interesting circumstances with respect to the sandstone, which are there visible. The strata may be traced for a considerable space up the valley, where they at length terminate in a succession of conglomerate beds; having, through the greater part of this tract presented no appearances requiring particular attention. Near their termination, they become erect, or at least highly elevated; and the conglomerate

is found unusually hard and condensed. In many places, it acquires that dark blue colour which so often occurs where it is traversed by trap veins. The colour of these beds, united to their erect position and compact structure, has caused them to be mistaken for veins of trap; an error easily committed. This mistake may however be corrected by a close examination; and it would not have been noticed but for the purpose of cautioning observers against judging in similar cases from any evidence short of a careful manual investigation. One or two narrow veins of this substance are nevertheless found here in the bed of the river; but they bear a small proportion to the rock now described, while it is at the same time very difficult to distinguish them among the rest. It is probably owing to these veins that the sandstone has here, as in other instances along the shore, assumed the peculiar colour it exhibits.

Near this spot, veins of sulphat of barytes are found. These are numerous and of large size, traversing the sandstone in different directions. They are for the most part solid, and present the mineral only in its massive form; but some imperfect crystallizations have occasionally been found in them.

The proximity of the granite to the sandstone is here such, that strong hopes are at first excited of being able to trace their contact and ascertain their junction. They can be distinctly followed till within 100 yards, or less, of each other; not the least indication of the intervention of schist appearing, either on the sides of the hills which bound the river, or in its bed, or from the presence of loose fragments. Unfortunately, the interval where the contact might be expected, is so completely overwhelmed by enormous loose blocks of granite, and the fixed rocks are so concealed from view, that not a conjecture can be formed respecting their nature. The research is equally fruitless in the hills above; the deeply covered nature of the ground, and the absence of streams sufficiently

powerful to expose the subjacent rock, producing the same unsurmountable obstacles in these as in the valley beneath.*

In returning from Glen Sannox along the shore, for the purpose of continuing the observations on the sandstone, no remarkable appearances occur till we arrive at Corry; the strata continuing also to present the same dip which prevails from Scriden southwards. Near that village, the white sandstone is followed by an alternation of strata similar to those already described on the northern side of Scriden, but more limited in extent, and far short of them in variety as well as in number. The red and the white sandstone, as well as the limestone, have here been quarried for economical purposes, and these quarries having been long wrought to a considerable extent, great facility is afforded for examining the order of the strata. They are not however so distinct or decided as to render it necessary to describe them very minutely. The beds of limestone which form the lower and most conspicuous portion, are numerous, and divided by thinner beds of coloured shales, similar to those which occur towards the north, and often abounding in oxide of iron. These are followed by thicker beds of schistose clay, or marle, variously coloured, and often much mixed with calcareous earth; to which succeed alternations of highly argillaceous sandstone, and of the same marly shales; the series terminating finally in a whitish sandstone. The characters

* To pursue this investigation it would be proper to commence either at Screed (formerly described) or in Glen Sannox, tracing the boundaries of the granite and the sandstone carefully along the whole line, between the two. If the schist disappears from the hill after leaving Screed, the geologist will naturally increase his diligence, and may possibly under favourable circumstances determine a point which I am compelled to leave in doubt, having hitherto been always impeded by the unfavourable state of the weather. In the accompanying map I have, as before remarked, traced the line in question by a white space between the granite and sandstone; and that line will point out the direction to be taken by those who may be inclined to enter on this task.

of the limestone vary in different parts, but its colour is generally a dark purplish grey. It is often very impure, being much mixed with clay and siliceous earth; particularly at the surfaces of the beds, where it generally passes gradually into the marle. It is at times of a conchoidal or flat and smooth fracture, at others granular, with a grain more or less large. These beds, whether calcareous or argillaceous, contain various entire shells, together with fragments of the same bodies, and specimens that appear to have lost their original forms by pressure. The nature of many of these fragments, and of the compressed and distorted shells, cannot be ascertained, but some of the latter seem to have been pectines. The only entire shells which I observed were two species of terebratula, and I am not aware that those who have made mineral conchology their study have yet assigned specific names to them. It is rare to find the individuals, in the rocks of this era, sufficiently perfect to exhibit those minute circumstances of structure on which specific distinctions are founded. Besides these shells, some of the beds contain madreporites.

The preceding description comprehends only one set of these beds, being that wrought in the oldest quarry; but there are similar alternations in other places, which it is unnecessary to specify, as they are but repetitions of the former. It is proper here to remark that these strata are not only inclined to the south-east, or thereabout, conformably to the general position on this side of Scriden, but that the angle is here considerable, the quarries being situated in the hill. At the same time, the large shells are all placed with their convex surfaces towards the bottom of the stratum; a circumstance well known to be common in similar cases.

Proceeding further southward, a frequent alternation is seen between the red and white sandstone, for a considerable space; until at length the former takes exclusive possession of the ground, continuing to Screeb. Here

also, quarries have been opened at a considerable elevation in the hill; in which may be seen strata of limestone and shale, so like to the last that it is superfluous to describe them, as the series differs chiefly in being of less extent. Among these beds the same large terebratulæ described at Corry are also to be found; their position with respect to the strata being even more conspicuously parallel.

It is not far from this place that the junctions of the schist and granite, and of the sandstone with the schist, formerly described, are to be seen. The bed of schist being here thin, and the distance between the granite and the sandstone consequently small, some hopes arose that, by pursuing the edge of the schist, the contact of the sandstone and the granite would be detected. Accordingly I found them in a torrent approaching within a few feet of each other; the erect and disturbed position of the sandstone always increasing as it approached the granite. Unfortunately, as too often happens, a concavity has been formed at the place where the latter disappears; so that this junction, if it actually exists, is rendered invisible by an accumulation of heavy blocks in a situation from which they may never perhaps be removed. The peculiar interest which has hitherto characterized the secondary strata, ceases at this point, and the remainder is little better than a dry topographical detail, which must nevertheless be given.

The red sandstone continues from Screeb to skirt the side of the mountain, and, as before, to occupy the shore to Brodick bay, where the great extent of alluvial matter prevents it from being any longer visible. But it may be traced hence within the land in several directions; rising up into the hills, and occupying positions, which, from the nature of the surface, are no longer so obvious as they were along the line already described. In this manner, it is to be seen along both sides of Glen Rossie,

being followed downwards, as might from previous observations be expected, by the schist and the granite. It may also be observed occupying the sides of Glen Shira, and extending along the Brodick road to a distance indicated in the map, so as to form the mass of a nameless hill; its position being erect, irregular, and apparently much disturbed. Here, and to the southward of this place, it becomes connected with a new series of rocks, the trap, syenite, and porphyry, which will be described hereafter. At the back of Brodick wood a bed of limestone is found to alternate with it, and shale is also seen in different places, similarly alternating, but never in a very conspicuous or extensive manner. There also, the conglomerate is to be observed mixed with the fine sandstone in the irregular manner which might from previous description be expected.

To prevent unnecessary repetitions respecting that which can have no further interest in a scientific view, and is of no moment even in a topographical one, I shall here premise, that although the secondary strata found in the other parts of Arran still undescribed, consist chiefly of the common red sandstone, yet that the conglomerate, the shales, the white sandstone, and the limestone, are occasionally found with it; never abundantly, and scarcely ever attended with circumstances which render it necessary to note the places where these variations or subordinate substances occur. In a general view, the whole mass may be considered as consisting of red sandstone; where conspicuous changes are found they will be noted in their proper places. I must here however mention, that fragments of limestone have been found between Brodick and Shiskin, and in other parts of the island, which have been described as *transition* limestones. The specimens in question are all derived from beds occurring in the red sandstone in these different places; nor is there

the slightest evidence of any other class of rocks than those already mentioned in the general sketch of the island.

It is perhaps already understood, that the angle of the dip of these remaining portions is generally so low that no access is any longer to be obtained to the lowermost beds. This is the case on the sea shores, where the most continuous and accessible masses are to be seen. But it is necessary also to remark, that, from the superincumbence of trap, the portions of sandstone found in the hills neither present any continuous extent, nor, as in the elevated portions of the northern tract, expose their broken edges so as to give access to their alternations or lower beds.

As the sandstone is found in the lower part of Glen Shira, so it extends up Glen Cloy, and across the land towards Lamlash bay; in which situation however it is so often covered by the rocks already mentioned, that a continuous tract is never to be seen. It is most continuous and best exposed to observation on the shore between Brodick and Lamlash bays; where it is covered by beds of trap, and intersected, not only by trap veins, but by veins of porphyry, claystone, and pitchstone. It is unnecessary to dwell on the portions which continue to be visible at Kilbride, round the skirts of the bay and within the land; but I may remark, that the most extensively continuous tract perhaps throughout the island, is that which occupies the segment cut off by an irregular line drawn between Kilbride and Kildonan, including Whiting bay. Even in this extensive mass, trap as well as porphyry is occasionally found, showing that either veins or overlying masses exist throughout it.

The state of the sandstone in the remainder of the southern division is such, that nothing but the most general description of it can be given. Occasionally, it is to be seen over the whole tract, wherever the

section caused by a torrent, or other fractures sufficiently deep, have exposed the rocks. To detail these places is impossible, as no mode of reference exists, but it is every where plain that it forms at least the principal and lowermost portion of the land; and that it is irregularly covered by the rocks to which I have already more than once alluded. On the shores it is more exposed, and the nature of its connexions with these latest rocks, may here be studied to advantage. Near Blackwater bay, the interruptions thus caused are frequent and very interesting, as they also are at the Bennan head, and at Kildonan castle. Near Coryravie, where trap veins abound, the strata are much confused and mixed with shale. Within land, the course of the Sliddery presents the most conspicuous and extensive portion in this quarter, and here it is abundantly interstratified with shale.

A peculiar circumstance occurs in the sandstone at the places where it joins the masses of claystone or porphyry which so often interfere with it. Within a few inches of these junctions, it acquires a more indurated texture, and when broken and held so as to reflect the light, a section or fracture of a quartz crystal may be perceived. This appearance is analogous to that which occurs in augit rock, and it may perhaps be supposed to have resulted from the action of the neighbouring vein. It occurs also in similar situations in Lamlash island.

There is not much more of the sandstone to be found requiring description. Between Drumodune and Tormore, both the red and white kinds occur in horizontal beds, and they are here very much intersected by veins of pitchstone, porphyry, and trap, and intermingled with masses of some of these substances. Between the Machrie and the Iorsa, the red sandstone is again seen extending for some little way up the course of that river; the beds being here in an

elevated position, as in all other situations where they approach the granite. This remark must already have suggested itself to the reader; but as this appearance involves some important questions, I shall dwell a little more largely on it, and proceed to consider how far many of the remarkable circumstances that have passed under review involve questions of general interest in geological science.

It has been shown that in all those parts of Arran which are remote from the granite mountains, the secondary strata occupy a position, either horizontal, or little deviating from that; if we except a few very local and limited disturbances which occur in the vicinity of certain rocks of trap and of the other analogous substances. But where the same strata approach the granite, they are in a certain degree adapted to its general outline; being elevated at angles, often of considerable inclination, and incurvated to suit the forms of that rock, or those of the primary strata which are interposed. It has also been shown that the tendency, as well as the quantity of the dip, bears a relation to the form and position of the mountains; the whole marking the general adaptation of the secondary strata to the basis on which they repose. It will naturally be asked, whether these strata were deposited in the position which they at present occupy, or whether that has been altered in consequence of subsequent changes in their foundation. The phenomena to be witnessed in numerous alluvial deposits, show that stratification is not necessarily limited to a horizontal plane; but that a regular succession of substances can be deposited in beds, on planes of considerable inclination. But this argument does not apply to the strata under consideration. The necessary position of an empty shell of a certain concavity subsiding in water, is sufficient to determine the original position of the stratum in which it lies; and it has been shown, that in different

parts of these strata, such shells are found, truly placed with regard to the plane of the bed, but not according to their tendency to subsidence. These strata are therefore displaced, and it may thence be concluded, that all the strata which follow them in a regular order, have been similarly changed from their former to their present position. There are but two modes in which this change can have been effected; namely, by the elevation of the ends next to the granite, or by the depression of those most remote. If the often discussed phenomena of the junction of granite and schist are allowed to prove the elevation of the latter, it may follow that the same cause has elevated the secondary strata, and that the granite is posterior to them, as it is to the schist.* The strong resemblance formerly noticed between the greater part of this granite and some of the overlying syenites, will perhaps add an argument in favour of the same supposition. I have pointed out the striking similarity between the syenite of St. Kilda, that of Von Buch, and parts of the granite of Goatfell. This similarity prevails through a considerable space in the other mountains connected with that hill. The resemblance between the syenite of Benderig in Sky and the granite of Glen Catcol, is equally striking, and the extent of correspondence greater; since nearly the whole of Ben vearan, Ben breach, and Ben huish, consist of this variety. Hence it may be conceived, that these different rocks may possibly be of the same relative dates to the secondary strata; the only criterion still wanting to establish their identity, being the presence of any portion of the granite of

* It is under this supposition, that the junction of the red sandstone and the granite, is an interesting object to discover; if indeed there be a junction of these two substances without the intervention of the schist. Should granite veins be found passing into the red sandstone as well as into the schist, this fact would be considered as established; at least as far as it is in the former case.

Arran actually overlying or traversing the secondary rocks of that island. Any portion would be sufficient for this purpose; since, as the overlying syenite is proved to be connected with masses inferior to the secondary strata, it would be indifferent, in establishing the claims of any analogous rock, whether the larger visible portion of it was superior or inferior to those strata. The want of this criterion is doubtless a most important, but it is not an unsurmountable, objection. I have formerly shown that in Sky there are detached portions of syenite, often of a granitic texture and composition, lying on the secondary strata, frequently limited to a very small space, and now separated by a considerable interval from the larger masses with which they were probably once connected. Since it was also proved that this rock was very subject to decomposition, to such a degree indeed as even to render its annual waste sensible, there is little doubt that it once covered many parts of the secondary strata from which it has long since disappeared. Should circumstances remove the very few portions still displaying its actual superposition to these strata, there would be no criterion by which to judge of its overlying nature, and it might therefore be mistaken for a mass of granite of an origin prior to the secondary rocks; a supposition that would be strongly confirmed by its granitic composition. On such a supposition the syenite of Sky becomes the granite of Arran: it only remains to imagine that those changes which time has not yet completed in the former have been accomplished in the latter, and the granite of Arran becomes the syenite of Sky. This question is not visionary: but it must not be pursued with visionary arguments, and I shall therefore leave it for future and increased experience. Geologists will have no more reason for surprise if the former continuity of the granite, the porphyry, and the trap of Arran, should be established, than by finding that

rocks not distinguishable from them in character, have been proved to be at present so connected in Sky.

There is still a fact in the history of the secondary strata of this island, which adds some weight to the opinion that the granite is posterior to them. If we trace round the skirts of the Highland mountains, that line of sandstone and conglomerate which reposes on them and is a continuation of the strata of Arran, we shall find that the conglomerate varies in character in different situations, partaking invariably of the rocks on which it rests. Where there is granite in the neighbourhood, it contains fragments of that substance; in the neighbourhood of Oban it contains trap, near Troup head, schist, near Stonehaven, jasper: these substances being severally found in the adjoining mountains. When these do not exist in the mountains, their fragments are not found in the conglomerate; and its composition is then comparatively simple. In Arran, no fragment of the neighbouring granite occurs in this bed; a circumstance which would be expected if the sandstone formation was of a posterior date to the granite. An objection however here presents itself, which must not be suppressed. It was demonstrated, that in one place the secondary strata are in a position unconformable to that of the primary schists which lie under them. These strata must therefore have been deposited on the schist, which had previously been deranged, either by the influence of the protruded granite or by other causes. But there is no difficulty in imagining that the protrusion of the granite had occurred at different periods; having elevated the sandstone and schist together, after the former had already undergone one disturbance. It is unnecessary to examine the hypothesis which attributes these derangements to subsidence, as no distinct evidence of such action has yet been produced.

Having thus discussed all that seems necessary respecting the position of the secondary strata with regard to the primary rocks, it is necessary to examine into their

original state as they relate to each other. It is well known that there is often a want of continuity or persistence in strata, and more particularly in those of small dimensions. In some cases they are wedge-shaped at both ends, or undergo in their progress a change from one substance into another. If therefore a given stratum cannot always be protracted with an uniformity of character for a few yards, there is no reason for assuming that it ever was so protracted for miles; and the want of distant correspondence in particular beds, will not therefore prevent us from legitimately concluding that the general body of strata on the north side of Arran, now interrupted, was once continuous.

It has been shown that the lowermost bed at Scriden is continuous, facing in two directions, and therefore incurvated on a centre, and that it is followed on each side of that point, by a great succession of strata increasing in number as they recede from it. The whole mass of strata thus following on each hand is accommodated to the position and shape of the primary rocks beneath; while the edges of both sets are abruptly broken, their middle portions gradually disappearing in succession towards the centre and towards the fundamental bed. It may therefore be safely concluded, that the outer, or upper strata, now separated by a considerable interval, have once formed a continuous series, of which the middle portions have been removed. If there is a want of accurate correspondence in the details of the northern and southern strata, they are still sufficiently similar in their general characters to justify this conclusion. It may yet be a question to which beds of this collection the sandstone which forms the southern parts of Arran appertains, whether to the upper or lower; and I know not that any answer can be given. It is not difficult to show that the unmixed red sandstone, which is found in contact with the schist as far as Glen Rossie, belongs to the uppermost series; since it can be traced from

Screeb with little uncertainty. But in proceeding beyond Brodick, it is no longer possible to connect the separated portions, either by following their continuity or comparing their positions; the interruption being here complete. For the same reason, no connexion can be traced between the northern upper bed at the Cock, and that which follows next in geographical order on the western shore at Glen Iorsa; the intervening schist occupying a great extent and producing a large chasm. It is equally impossible to follow the strata in the interior country. It may perhaps be reasonably supposed that these strata are continuations of the upper one, since they resemble it in the great proportion which the fine sandstone bears to the conglomerate, and in the absence of the smaller strata, which, were it the lower one, would be expected to appear above it.

A general question respecting the continuity of strata arises out of this investigation. Every deposit of secondary strata must, to a greater or less extent, be considered partial; there being no proof that they have ever possessed universal continuity. For this reason, the supposed identity of remote strata, derived from particular appearances, must be received with caution; since, both in practice and in theory, this supposition may lead to erroneous conclusions; while, like other hasty generalizations, it impedes the progress of investigation. If we examine the mode in which stratified rocks appear to have been formed, there will be no difficulty in acceding to this doubt, as well in the case of the more general, as of the more limited strata; since the same circumstances must, under certain variations, have attended the formation of both. These deposits have perhaps originated in diluvian causes and remote times; more probably from the gradual action of rivers on pervious rocks. Being received in cavities or in seas of different forms and capacities, they have been consolidated by pressure, repose, the partial solution and crystallization

of earthy matters, or lastly, by unknown causes. It is easy to comprehend how the varying form of the bottom, the irregularity with which the substances were deposited, the flowing of rivers from mountains of different materials, and the consequent deposition of different substances on different parts of one common bottom, should have produced the diversities of composition now visible, and occasioned the want of lateral uniformity in the composition of any one stratum. As the magnitude of any one deposit is thus regulated by the shape and extent of the cavity in which it has been formed, so will any given collection of strata be more or less extensive; while its lateral uniformity will depend on the identity of the substances which have been deposited over the whole of such a supposed surface. It is easy, for example, to conceive that if a continuous stratum were to be formed along the southern coast of England under the present sea, the western parts would consist of sandstone and shale, from the ruins of granite; while in another place it might be of a calcareous nature, and in a third of a still different composition.

The last subject to be considered respecting these secondary strata, is their analogy to those that correspond with them in geological position on the continent of Scotland. It will hereafter be shown in considering the estuary of the Clyde, that the sandstone of Arran is a portion of the great mass which occupies the middle district of Scotland and terminates on the west side of the Mull of Cantyre. The conspicuous differences between the two, consist in the greater variety of substances presented by the former, and in the great proportion which these bear to the simpler rocks that give the prevailing character to the whole. Many of them however occur, although in less proportion, elsewhere, as, for example, in Bute; and will perhaps be considered by some geologists as mere variations of character, while by others they are viewed as accidental and subordinate substances. With

respect to others of these strata there is more difficulty; nor can it be positively determined from the limited appearances here visible, whether, like the former, they are merely variations in the character of the leading beds, or disjointed and limited portions of those secondary rocks which in other situations follow the red sandstone in a regular order of superposition. If all the established successions of strata were equally regular every where, this difficulty would not exist; but as many of them are occasionally absent, or irregular in their proportions, we must, in cases like this, where small and insulated tracts alone are the subject of investigation, unavoidably remain in doubt; unless we can deduce from the comparison of relative positions, that which is not obvious to simple inspection. I allude here principally to the white calcareous sandstones and the red calcareo-argillaceous beds that contain entrochi; the true connexions of which are not completely evident in the places where they occur. Some of the limestones appear to be subordinate, or accidental concretionary deposits in the red sandstone; similar beds occurring in Bute and in other places on the skirts of the Highland mountains. Those beds which contain terebratulæ have by some been considered analogous to that which has been in England called mountain limestone; a supposition which, if proved, would show that Arran presented one set of strata at least in a regular order of superposition to the red sandstone. Should this be considered the fact, the white sandstone which follows the limestone would also be a third and distinct deposit; this stratum, where it occurs, appearing to be the last and uppermost in the island. In the same way, the large mass of white sandstone in contact with the red, would also be esteemed a portion of the same deposit; the limestone having disappeared, as occasionally happens among stratified rocks, by the gradual extenuation of the beds, and thus suffering it to come into immediate contact with the lower red one. Thus also

the coal would be considered as appertaining to a regular series including this substance, of which the strata of calcareous sandstone would be the principal member.

But that evidence which, in Arran, is defective in the separate portions, is compensated by a comparison of the whole series of secondary rocks. It is thus proved that the outer strata on both sides, have been broken and removed in succession towards the middle of the whole deposit as it is displayed on the eastern shore; thus giving free access by a wide and perfect section, from the surface to the foundation, in that part where the series is most complete. Thus the coal, like the white sandstone and all the various strata that have been enumerated, is contained within the red sandstone, which, without any change of character, succeeds to these beds while it also precedes them. This is not a solitary phenomenon, as coal occurs in the south of Scotland in the same situation. In what respect the red sandstone of this latter district may be connected with the red marle of English geologists I cannot determine, being unacquainted with that tract of country; but the little that remains to be said on this subject will be advantageously deferred till the remaining islands of the Clyde, where the same rocks occur, have been examined.

I MUST now proceed to the consideration of the remaining rocks of Arran, which are generally found in a position superior to the sandstone, and may therefore be considered as of later origin.

Their general places and relations have already been mentioned, but it is difficult to give a distinct account of them in detail. This arises from the very limited view of them which can be obtained, owing to the form of the ground and the nature of the soil. It was before remarked that in the case of stratified rocks it is easy to infer the nature of a considerable space from the com-

parison of distant points, regard being had to the disposition of the strata. This can sometimes be done even in granite, although not a stratified rock, since it is consistent in maintaining its unstratified character and its inferiority of position. But the rocks under review are sometimes disposed in shapeless overlying masses; at others in beds parallel to the strata, and either superior or inferior in position, while in still other cases they intersect them,* forming large intruding masses or smaller veins. Hence arises that perplexity which prevents any accurate inferences from one portion to another; so that the account of any mass can scarcely be extended beyond the immediate point of observation. They are well known by the several names of basalt, greenstone, syenite, claystone, clinkstone, compact felspar, and porphyry. But these rocks will all, I believe, be found to pass into each other by regular gradations; while the connexions of all of them with the stratified rocks are the same.

It will on the present occasion be convenient to invert the usual order of description, and to examine the several rocks and their characters before describing their places. Much repetition will thus be saved, and if, as will frequently happen, a claystone be found porphyritic where I have represented it as plain, the reader who may follow this description through Arran, will feel no surprise; knowing that such variations are of frequent occurrence.

I shall begin this series from claystone, as being perhaps the simplest. This rock is not uncommon in Scotland, since well characterized examples of it occur in the Pentland and in the Ochil hills. It is to be seen in Arran, passing by various stages into compact felspar or into felspar porphyry, but is not found in any considerable quantity in its simplest state. In the first state of induration however, it occurs abundantly, and under such an aspect that mineralogists will perhaps rarely agree

* Plate XXIV. fig. 4.

in assigning the same name to it. It may indeed be called indurated claystone, but it may also with as little error be considered a variety of clinkstone or of compact felspar,* since it is not far removed from these substances. As the term indurated claystone is however in many cases very convenient, I shall for the present adopt it.

As this rock continues to increase in hardness, it is frequently characterized by an imperfect granular fracture and more sandy texture, as well as by an occasionally carious or cavernous aspect; while it approaches so much more nearly to clinkstone that the term arenaceous clinkstone may, for want of a better, be used to distinguish it. This term is expressive of its appearance, since it often resembles sandstone so strongly as to have been mistaken for it by mineralogists who have visited and described Arran. There is however reason to suspect that this appearance is the result of an incipient decomposition.

In a further state of induration, and still retaining a simplicity of aspect, it puts on other characters, becoming so various in texture, colour, and general appearance, as to be often a source of error to mineralogists, who are easily led to confound the dark-blue, or speckled varieties, with basalt or with fine greenstones. The predominant colours are pale ochrey white, fawn colour, brown, and lead blue; and the same colours occur in the analogous rocks of whatever degree of induration. The latter varieties are often remarkable for the deep stain of yellow which penetrates from the surface; the effect of the carbonization of the black oxide of iron whence the substance derives its dark colour. With attention, such dark varieties are generally to be distinguished from greenstones or basalts; since both the latter derive their colour from

* I have here used the term compact felspar in common with other mineralogists, although not convinced of its propriety; since the substance in question appears to contain soda, while felspar contains potash only.

an intermixture of hornblende, a mineral which does not enter into the composition of this substance. This is the particular rock to which it would be convenient to limit the name of clinkstone, which thus becomes the third in order from claystone, compact felspar being the last. The term is indeed in use for this purpose among mineralogists, but has been also often applied to the softer substance just described, as well as to compact felspar. It is in truth difficult to limit names very accurately, when the limits of the approximate rocks are themselves evanescent. The several varieties of the clinkstone, as it occurs in Arran, are sometimes massive, sometimes prismatic or even regularly columnar, while in other cases they are schistose; nor is it uncommon to find masses which are columnar in one part, becoming schistose in another, and even the columns themselves splitting naturally into laminæ at right angles to their axes.*

* This variety is the porphyry slate of some authors, although that name has, indeed, been extended to some of the rocks of this family which present no appearance of a schistose structure. As a specific name, it is unfortunately chosen; since it is founded on a circumstance merely accidental, and occasionally occurring in almost all the leading members of the overlying rocks. In this particular case, we have already the specific term of claystone porphyry; while the schistose structure is, moreover, but occasional, and generally occupies but a small part of the whole mass; it can only be considered as an incidental variety. As the same rock occasionally presents the prismatic or columnar disposition, it might with equal justice claim a specific term expressive of this as well as of the former structure; a practice, which in the case of basalt, has long been rejected by mineralogists; the form being considered among the accidents of the mineral. Should the schistose structure be considered a specific distinction, the same rule must be extended to the other members of this family; and thus the soft blue claystone and the syenite of Mull, the overlying trap of Sleat, and the veins of Isla, would aspire to the rank of species. Nay, it might even be extended to granite, and thus the schistose granite of Catcol must also be erected into a new species by the name of granite slate. It is unnecessary to produce further arguments for the propriety of rescinding the term of porphyry slate from the mineralogical nomenclature.

With a smoother fracture, either plain or conchoidal, and a translucent fragment, this rock becomes compact felspar, (the hornstone of some) which, however occasionally found unmixed in Arran, is more generally porphyritic; containing crystals of felspar more or less numerous and remarkable.

As the various porphyries form a conspicuous feature in the island, it is necessary to give a general sketch of their appearances. They are still but varieties of the simple rocks above described, since their geological connexions are the same, and their actual continuity can in most cases be traced. Each of the substances just enumerated becomes occasionally the base of a porphyry, and many varieties in colour as well as texture are thus produced; further increased by the more dispersed or condensed numbers of the felspar crystals, as well as by their varying magnitude. Among the most remarkable of these, I may enumerate one consisting of a grey felspar base with large white crystals, another of a pale blue with white crystals, and a third, still more remarkable, well known as being found at Drumadune. This porphyry, in a base of compact felspar or clinkstone, contains large crystals of earthy, of common, and of glassy felspar; together with transparent grains of quartz, which have often the form of crystals of which the angles have been rounded. The base varies in colour, from greyish white to dark lead blue; and, in the latter case, cannot be distinguished from many varieties of trap. But the base of the porphyries, simple in the above cases, becomes sometimes compound, by the intrusion of quartz into its composition; and thus there is formed a rock from which the imbedded crystals of felspar again disappear, leaving a simple and granitic mixture of felspar and quartz, often stained with spots of oxide of iron, as if from the decomposition of pyrites, hornblende, or some other mineral. This compound has obtained no distinguishing name, nor perhaps is it necessary, since it is easily arranged with the varieties of

syenite, a substance which has given its name to a leading division among the rocks of this family. As, in strictness, syenite is a compound of hornblende, quartz, and felspar, although, as in St. Kilda, Muil, Rum, and Sky, the hornblende is often wanting, the mineralogical character of the above mentioned rock is imperfect.*

In terminating this brief account of the varieties of these associated rocks, it may be remarked, that in some places, a fine breccia may be observed, consisting of fragments of different colours, either of compact felspar, or of the other analogous substances, cemented in a basis of the same nature. I may also add that in some specimens I observed distinct crystals of augit, and in others, concretions of epidote entering as ingredients.

In describing the varieties of trap, commonly so called, which here occur, it is unnecessary to enter into minute particulars; as these rocks have so often already come under notice.

Among these, greenstone is by far the predominant substance, but it occurs under a great diversity of aspect; appearing also to be derived from two distinct varieties of

* The syenite of the trap family, though nominally the same as the syenite found with granite, is almost always distinguished by a peculiarity of aspect easier to recognise than to describe, and most frequently by the nature of the felspar. In certain cases, it is true, the resemblance is strong; but it is necessary, for the purposes of geology, as before remarked, that the two rocks should be distinguished by appropriate terms. The syenite found with granite might perhaps be conveniently distinguished by the name of syenitic granite, a name, if one is really requisite, sufficient to discriminate its mineralogical character, without confounding its geological relations. By this simple arrangement, a confusion to be found, even in very recent geological writings, and, in some cases, generated by the ideas attached to these terms, is avoided. It is unfortunate that this term should have been applied to two rocks differing in such important circumstances; nor is it easy to account for its choice as originally applied to the overlying rocks; since the well known Egyptian rock whence it was derived, is a granite in geological connexion, and presents decided granitic characters. The observations of recent travellers who have visited the quarries of Syene, prove that they are situated on the skirts of the granite mountains.

the compact felspar, or clinkstone, the one of a dark, the other of a light colour. In the former case, the addition of the hornblende to the basis of clinkstone or compact felspar, is so gradual, that the change is at first not perceptible, and specimens of the two rocks are therefore easily confounded. This also results in other cases where the quantity of the additional ingredient is considerable; the dark colour of the compact felspar concealing that of the hornblende.

As it is often impossible to assign names to these transitions, it is not surprising if different observers disagree in describing these rocks, by referring them to one or other of the extremes. But the transition from the white or pale varieties, is more defined as well as more obvious; and the specimens are often interesting from the beautiful manner in which the hornblende crystals are disposed in the basis or intermixed with it. Sometimes they appear in the form of small obscure spots, as in the rock of Ailsa; in which case if quartz be also conjoined to the felspar in the basis, the rock will be a syenite instead of a greenstone. In another case they are disposed in an arborescent manner, in a third in long distinct prismatic crystals; while the gradual increase of the hornblende at length produces greenstones of a more ordinary aspect, which are, in a further progress, to terminate in basalt. These several compounds vary much in the magnitude of their crystallization, and in one part of the island, (not far from Glen leg) three distinct kinds are found aggregated together in one rock; in that respect much resembling those varieties of granite, described in the beginning of this account, which contain fine grained concretions imbedded in a coarser basis. A variety still more singular occurs in the same place. This consists of a mixture of two distinctly coloured greenstones, the one nearly white, and the other nearly black, from the different proportions of hornblende in them; being

sometimes joined in such a manner as to resemble a conglomerate rock, while, in other cases, ramifying veins of the white are found passing through the dark variety. It is not easy to explain this appearance, nor to determine whether these are real fragments or only accidental modifications in the distribution of the substances which form the greenstone. Real trap conglomerates are also found associated with the other greenstones, in the usual irregular manner in which they always occur, and often presenting a considerably indurated texture.

The last and most rare variety of greenstone to be noticed, is of a dark colour and coarse texture, strongly resembling some of the rocks formerly mentioned as found at Harris in Rum. It contains augit, and, generally also, compact mesotype (possibly nadelstein); this latter compound resembling precisely the rock found at Eilan Wirrey in the Shiant isles, and in Sky. It must be remarked, that the mesotype does not here occupy an amygdaloidal cavity, but is confusedly united to the other ingredients, forming a regular constituent part of the rock. It seems occasionally to pass into chalcedony, into quartz, and into prehnite; but the minuteness and imbedded position of the globules prevents these changes from being accurately examined.

It may be added to this account of the varieties of greenstone, that it occasionally occurs of a porphyritic aspect; and it is unnecessary perhaps to say, that basalt is also found among the other rocks of this division; sometimes in the overlying masses, but more frequently in the veins.

Having thus considered, in as much detail as appears necessary, the several substances which form the overlying rocks of Arran, it remains to describe their geological connexions with each other and with the stratified rocks; together with such parts of their topography as are either

requisite, or, from the imperfection of the modes of reference, practicable.*

It has already been shown that the greater part of the southern district presents indications proving that it is formed of a basis of red sandstone, covered and obscured in various places, and throughout the greater part of its extent, by overlying masses of unstratified rock. These consist principally of the several varieties of felspar rock, a certain extent of trap being also found associated with them. The causes already pointed out, consisting in the nature of the soil and the shape of the ground, which render it impossible to assign the points where the sandstone appears at the surface, equally prevent any accurate account of the places of the overlying rocks. In a general view they may be considered as occupying all the higher parts of the land; while the sandstone, inferior to them, is only to be seen where natural causes have eroded the beds of torrents; or on the sides of hills where the surface has undergone changes of its original form. I must refer to the map for the only record which I can give of these rocks over the principal part of their extent within the interior: it is necessarily of the most general nature; since the want of local names, no less than the geographical

* As all the substances above described are associated by the common bond of connexion and transition, and by that of a common position with respect to the stratified rocks, a common geological term might here be adopted for the whole. But to accommodate as much as possible this description to the prevailing practice, that of trap will be applied to the greenstone, basalt, and amygdaloid; although some of the other division will occasionally and unavoidably be included under it. For that division, the term of felspar rock will be adopted, which, however objectionable, is convenient because it is indefinite. The use of any of the ordinary terms for this purpose, such as claystone, clinkstone, syenite, or porphyry, would be more objectionable, from their definite meaning; while to name each individual variety in treating of the general details, would lead to perplexity and tedious repetitions. It will be sufficient to specify them in their most important situations.

imperfections of the map of Arran, prevents any accurate references. The predominant varieties appear to be indurated claystone and clinkstone, which, either in a simple state or slightly porphyritic, occupy by far the larger portion of the ground, displaying sometimes the prismatic and at others the schistose structure; while they are occasionally of a dark blue colour, but generally of a pale greyish white. In proceeding to point out such places as admit of a more acurate description, it will be perceived that these occur chiefly along the shore, where considerable sections are exposed to view.

A remarkable porphyry was mentioned as forming the promontory of Drumodune. This is a large bed, extending, as its broken front, about 500 yards, and being there, on an average, about eighty feet in thickness. It is divided into prisms perpendicular to the bed, which give it, in a general view, a columnar aspect; but they are neither defined nor regular. It lies upon the sandstone strata, which can be seen in a horizontal position in different places; but is separated from them by a laminar intermediate mass which is not porphyritic. This consists of the basis of the porphyry without the felspar crystals; approaching to compact felspar, and of different colours, iron grey, brown, and pale grey; all of which are occasionally found in the porphyry itself. To illustrate the nature of this rock, it is here necessary to mention, that to the westward of this point a large vein of the same porphyry occurs on the shore, the sand of which prevents its connexion with the surrounding rocks from being traced. But on the east side of Drumodune, towards Tormore, at a place conspicuous for pitchstone veins, another of a very large size, and of the same nature, is to be seen traversing the sandstone; together with some smaller veins which it is unnecessary to specify more particularly. The most extensive mass of this porphyry lies between Blackwater bay and Sliddery, where its broken edge can

be traced all along the shore. I did not there discover the sandstone below it, and I cannot therefore determine whether it is in the form of a vein or an overlying mass; an object of no consequence in a scientific view, as it was just shown, that, at Drumodune, it exists, like the other varieties of felspar rock, in both these states. This rock can be traced to a considerable distance inland; but its connexions and boundaries are there as obscure as those of the other rocks already described. I must add that, throughout this porphyry, irregular concretions and imperfect veins are occasionally to be found, consisting of the base alone, void of crystals, and on a first view resembling ordinary trap veins: an appearance very analogous to some of those well known veins and concretions that occur in certain granites.

Thus far only does it appear necessary to describe the overlying rocks of the felspar division which occur in the island; any further attempts at individual description would only lead to a fatiguing repetition, without benefit to the science, or utility to the geologist who may hereafter traverse the same ground. The veins however, present somewhat more variety and greater interest; while it is at the same time more easy to refer to their places; the most conspicuous being tolerably well indicated by geographical marks.

One of these veins is to be seen on the shore near Corygills, between Brodick bay and Clachland point. From the manner in which it appears in the cliffs, it is on a first view scarcely distinguishable from the sandstone in which it is enveloped, and has indeed been described as a white columnar sandstone. On comparing its position however with that of the sandstone, it is easily seen to be a vein placed at an angle with that of the strata in which it lies; its dip being towards the south, at thirty degrees or more, while the surrounding sandstone is placed at a much lower angle. It is about thirty yards in thickness. It consists of a pale yellowish white clinkstone, at times slightly porphyritic, and exhibits two distinct structures;

a prismatic one at the bottom, and a schistose near the upper surface. This latter surface is in contact with fine sandstone, while the lower side rests on conglomerate. If the examination of this vein be continued on the flat shore, it is found closely united to a large trap vein, which at first sight appears to form a part of it; being parallel, and generally in close contact, and running east and west with a common dip of thirty degrees to the southward. The appearances are so peculiar as to deserve a more particular detail and a diagram.* By a minute examination, it will be found that the conglomerate is occasionally interposed between the two, although often so thin as to be scarcely visible. Thus these veins are proved to be independent, and the connexion between them incidental. The fine sandstone lies beneath the trap vein, and is much intermixed with it; the trap appearing to be dispersed in lumps throughout the bed. Although the red colour of the conglomerate continues unchanged, the sandstone assumes the dark grey colour of the trap. Where the porphyry is in contact with the trap, it is undulated, and acquires an intense degree of hardness.

About a quarter of a mile further on towards Lamlash, another vein of this substance, still more remarkable for the peculiarity of its structure, occurs. As far as its general appearance and dimensions are concerned, it is so similar to the former as to require no particular detail: I may only remark that it appears of equal breadth on the shore, but somewhat less in the cliff. The appearances for which it is solely remarkable, are to be found at its junction with the sandstone on the shore, and are most conspicuous below high water mark; for which reason it should be examined at low water.

In some places, the sandstone is found to be much indurated at the junction, while the claystone or clinkstone is softened, as if in a state of decomposition. It must

* Plate XXIV. fig. 1.

be remarked, that, in both these veins, the texture varies, so as to admit in different places of both the terms just used, and that the vein now under review is seldom if ever porphyritic. But the circumstances for which this vein is chiefly remarkable are, a concretionary globular, and a striated structure; both of these being found in the immediate vicinity of the junction, and no where else. In some specimens, the former puts on the appearance of circular or elliptical spots, strongly resembling in aspect the well known spotted Siberian jasper.* The striated variety is either found separate, or united with the globular in the same specimen. In both cases, the spots as well as the stripes are attended with corresponding differences of hardness; the former arising from the globular structure, the latter from a schistose or laminar one. The spots being often elliptical, compressed, or elongated, occasionally become laminæ in the progress of elongation, passing into them by insensible degrees. That portion of the vein which lies near the sandstone, and contains these appearances, is very small, but varies much in hardness in different places; although it cannot be said that this induration bears any relation to its proximity to the sandstone. The concretionary structure takes place both in the hard and in the soft varieties; but with some differences, inasmuch as the globular bodies appear in the latter to be softer than the base, while in the former they are harder. They

* The term jasper has been used in so vague a manner, and applied to so many substances decidedly different in mineral character, that it is difficult to steer clear of ambiguity in speaking of its geological connexions. But if, in the present state of our knowledge, it may be limited, it will probably be found to appertain chiefly to the overlying or venous rocks of the porphyry family. In this way it occurs in Glenco, passing by insensible gradations into the common coloured claystones, and into the porphyry of that district. The well known mass found on the east side of Scotland near Fettercairn, seems also to be an independent rock intruding among the primary strata, in the same manner as the rocks of that family are known to interfere with these.

occasionally present a beautifully radiated fibrous structure; the radii sometimes diverging from a point, and at others from a solid nucleus, which is further in some instances surrounded by a white earthy crust. In the progress of induration the rock at length loses its character entirely, appearing to pass into a substance of an undefinable nature; of a horny aspect and dark dull green colour. It is possible to convey an idea of this substance by saying that it partakes of the characters both of chalcedony and of pitchstone: it has been sometimes improperly described by the name of globular pitchstone; a rock from which it is nevertheless far removed, by its extreme toughness, by the want of lustre, and by the form of its fracture. In these hard varieties, the circumstance formerly described as found in the concretionary siliceous schists of Scalpa and the Shiant isles, also occurs. The intermediate parts of the stone waste by the action of the water, the globular concretions remaining in a distinct form, and producing a botryoidal surface.

A third vein of the same porphyry occurs still nearer to Clachland point, but it is of smaller dimensions, and seems attended by no peculiarities.

A remarkable vein of a similar indurated claystone, is found near Machrie on the sea shore, lying between the mouths of the Machrie and the Iorsa. It runs nearly at right angles through the sandstone, which is here horizontal; being about twenty feet wide, and divided into irregular columns. The point of junction between this vein and the sandstone is not visible. But such junctions may be seen in many places on this side of the island, both at the contact of veins and of overlying masses. One of the most remarkable, occurs near Blackwater bay, eastward of Drumodune. A great continuous mass of the felspar rock, resembling a bed, is here to be seen; its mineralogical character undergoing, in different places, some slight changes which it is unnecessary to particularize. At one of the extremities, its junction with the

sandstone beds is found, and these abut against it; the ends of the strata in contact with the felspar rock, being slightly turned up out of their general direction. In following these strata eastward, the felspar rock is again seen passing once more in a vertical direction through the mass of strata, and with the remarkable appearance represented in the subjoined sketch.* Beyond this there is a third and very distinct vein visible, presenting a similar connexion and a prismatic fracture. It is in this place that the crystalline change of the sandstone formerly described, occurs.

It is unnecessary to describe any more of those veins that traverse the sandstone strata, as none of them appear to be attended by peculiarities worthy of notice. But it is a necessary part of their geological history to mention that they occasionally traverse the granite; in which respect also they present a common feature with the ordinary trap rocks. They are however far less common than trap veins in those situations, as I only discovered one example *in situ*, although indications of them are to be found in other places. The vein to which I allude is found near the summit of Goatfell, and consists of a grey compact felspar interspersed with white crystals of the same mineral. It is very intimately united to the granite at its edges. The indications above mentioned, consist in scattered masses of indurated claystone and of felspar porphyries, which are found on the sides of Ben vearan in different places, and are doubtless derived from veins, although I was unable to detect them. It is superfluous to enumerate any more of these local details, as they are uninteresting in a topographic view, and as the places already described afford sufficient foundation for examining the geological relations of the several rocks to each other and to the strata which they accompany. With respect to the former, all the varieties are found to be con-

* Plate XXIV. fig. 3.

nected by a common bond of mutual transition; and with respect to the latter, they all possess the double relation of intersecting them in the form of veins, and surmounting them in that of overlying masses; the same portion presenting both characters in connexion.

I shall now point out such localities of the trap rocks as are in any way interesting.

The mass of greenstone incumbent on the sandstone between Lamlash and Brodick bays, consists principally, if not entirely, of that variety described as containing augit and mesotype, and is properly therefore, an example of augit rock. The same variety occurs at Clachland point, along the shores of Whiting bay, and beyond that, towards Kildonan Castle; being in all these places found, both in an overlying position, and in the form of irregular masses intruding among the sandstone strata. At Kildonan a considerable extent of trap is to be seen; various in its aspect and structure, and forming a range of high cliffs; the shore itself presenting one flat bed, of which the surface is even, and divided into polygonal compartments. At the Bennan head, a similar cliff is to be observed, but of less extent; and here, as far as the ground will admit of observation, the whole mass seems, at one side at least, to pass through the sandstone strata which are found abutting against it: this mass is probably a large vein.

Masses of fine and coarse greenstone are found every where dispersed among the hills in the interior of the southern division of the island; but for the reasons already given, neither their true nature nor their extent can be assigned. They may either be veins or overlying bodies: in all probability both occur. The most continuous range of greenstone which I observed, is to be seen in the hills that divide the course of the remote parts of the Sliddery water from the Brodick and Shiskin road, where these rocks occupy a space of some miles in extent, but where their boundaries or connexions with the other rocks, cannot

I believe be traced with any certainty. The last of these overlying masses to be described, is conspicuous for its limited extent, as the former is for the great space which it occupies. It is moreover remarkable, as being the northernmost overlying mass occurring in the island; lying in fact immediately on the boundary of that line which was formerly described as separating the granite division of Arran from that in which the trap rocks form the leading character. It is seen on the brow of the hill over the head of Glen Shira, where that valley joins to Glen Rossie; lying above the sandstone and conglomerate, and not far from the place where these terminate to be succeeded by the micaceous schist. The area it occupies does not seem to exceed fifty yards in breadth, but it offers no other peculiarity requiring a further description.

It is unnecessary to say that Arran presents instances where the trap rocks are found in the same double connexion with the secondary strata as the felspar rocks are; since this fact is of universal occurrence; it is more necessary to inquire respecting the mutual connexion of these two classes of rocks. They pass into each other by insensible gradations, as they have formerly been shown to do in Rum. It is therefore unnecessary to inquire into the relative antiquity of these two sets of rocks; since we are thus entitled to conclude that they are of the same age, and that they owe their present position to a common cause, or at least to a series of common causes. For, although the circumstances now related, assign a common origin to the two divisions, it is not necessary that this should hold good of all the individuals. Appearances too well known among the trap rocks to require enumeration, and noticed in other parts of this work, show that there have been successive formations of them; since they are found in the shape of veins interfering with each other. There are not the same means of demonstrating a successive formation of masses, because, as formerly observed, the superiority of such masses

to an earlier or later stratified rock, proves nothing. Rocks intruding from below in a state of fluidity or softness, whether that fluidity arose from an igneous fusion or not, admit of no such registry of their ages. It is even possible, that in the course of future investigation into a set of substances hitherto imperfectly understood, the felspar rocks may be found in some instances demonstrably later, and in others earlier, than the rocks of the trap division.

A great resemblance is often found to exist between some individuals of the felspar division and others of the granite tribe, as well as between the latter and some of the trap division. That resemblance holds very strongly in comparing the transitions between the two divisions of felspar rock and trap, with the gradations which occur in the different kinds of granite. There are no greater differences among the transitions of the two former than can be observed in the latter; specimens of which are to be found, consisting at one extremity chiefly of felspar, with sometimes mica, at others quartz, or else with both these minerals superadded; while, at the other, they become so filled with hornblende that they can scarcely be distinguished from the greenstones of the trap family. It is equally easy to trace the continuity between those two extremities, in granite as in the overlying rocks; the varieties of aspect which it presents, being even greater than those which occur among all the individuals of the two divisions above described. In other respects there is a considerable resemblance between granite and the rocks in question; although these latter differ materially, in forming beds which lie over the secondary strata; whereas granite has not yet been ascertained to lie over the primary in the same manner.

Trap veins are abundant throughout the island, and, as is invariably the case, they traverse all the rocks which lie in their way.

It would be a tiresome, and now a fruitless, task to

enumerate them, since scarcely any one presents appearances different from those already described in this work. They sometimes consist of plain basalt, at others of a porphyritic basalt, or of greenstone; and occasionally, all these several substances occur in one vein. They are very abundant in Whiting bay, where they traverse the sandstone in all directions; at times passing through it in a course parallel to the beds. On the shore near Corygills, one, of large size, and nearly vertical, is found running S.W.; being very conspicuous, and accompanied by others of less note lying in various directions. This example has already been noticed in speaking of the great vein of porphyry with which it is associated; and it is further accompanied by another equally large, which crosses the same vein at a considerable angle, extending for some distance along the shore. On these I shall only remark in general, that many of them are laminated, and that these laminæ being of unequal hardness, they yield in an irregular manner to the action of the sea. Very often they may be observed to waste most readily where in contact with the sandstone; apparently from a difference of composition prevailing at the junction of the two substances. In some cases the sandstone has become indurated at the same place; but that is only to be detected after similar exposure to the sea; when a thin edge will be found projecting an inch or more above the general level of the rock, and accompanying the course of the vein.

These veins occur frequently along the northern shore in the space formerly described as occupied by the secondary strata. In one place not far from Scriden, a mass of sandstone is found included between two of them, where it becomes of a dark blue colour; the same hue also occupying those parts of the bed which lie immediately on the outside of the veins, while, in further progress, it resumes the usual red complexion. Between the exits of the Iorsa and Machrie rivers,

one is to be observed running parallel to a vein of felspar rock formerly described, resembling it exactly both in position and dimensions. They are also found, together with veins of porphyry and of pitchstone, near Tormore; where they are however no otherwise conspicuous than as they are posterior to the latter, and add to the general confusion of this intricate spot. They also occur in the course of the Sliddery water; but are perhaps most conspicuous between Coryravie and the Bennan head, where they run like walls far out into the sea; sometimes forming commodious breakwaters for small boats, and offering excellent foundations for piers, were such buildings wanted.

I formerly observed that trap veins are also found traversing the granite, but they are much less frequent in this rock than in the secondary strata. The cause of this will not appear difficult of explanation, when the circumstances formerly pointed out in the trap veins of Strathaird are recollected. It was there shown, that the greater number of these might be traced with much probability to the overlying masses of trap in the immediate vicinity, and that their courses were limited; often indeed confined to a very narrow range. The same consideration will explain their greater frequency in this island among the secondary strata; since the overlying masses are invariably superincumbent on these, and remote from the granite, which has thus been penetrated by only a few of the most persistent; possibly indeed, by veins of an independent nature, and of an era different from that of the overlying masses.

These veins occur in Glen Rossie, but without any peculiarities requiring detail. A very conspicuous one is also to be observed at the head of Glen Sannox; and of these I may remark in general, that their contact with the granite is always perfectly defined, and that neither substance appears to undergo the least change at the place of junction. Occasionally every other rock

has been found affected by the contact of a trap vein, but I know of no instance in which any similar change has been remarked in granite: I need not point out the very obvious conclusions that may be drawn from this fact.

Three or four of these veins are to be seen at the head of Glen Catcol;* one of which is so remarkable on account of its form, that I have been induced to give a sketch of it.† It demonstrates the forcible separation of the granite, since that rock has yielded in the direction of its joints, presenting an instance very similar to one already described near Coruisk in Sky. But I believe geologists will now scarcely require such evidence as this to prove that trap veins are posterior to the granite which they traverse. I need scarcely say that veins similarly situated have been called *primitive greenstone;* and it is equally unnecessary to point out the confusion produced by the use of a term so misapplied. I shall therefore dismiss this subject, and proceed to consider that rock for which Arran is so remarkable, being the last that remains to be described, namely, pitchstone.

The veins of pitchstone are to be seen in different parts of the island; while detached fragments of the same substance, found in many other situations, seem to indicate the vicinity of others not yet discovered. The most conspicuous and extensive of these yet observed,

* The rocks at the upper part of Glen Catcol are covered with the Ulva montana of Lightfoot; a plant so little common as not to be much known to botanists. Its genus may perhaps admit of a question, as it presents the habits of a Tremella rather than those of an Ulva. As there is no figure of it extant, I have added one in Plate XXX. It is there represented in fructification, when the leaf thickens and curls up; before that period it is a thin membrane, moderately undulated.

† Plate XXVI. fig. 3.

occurs in the cliffs between Corygills and Clachland point; resembling so strongly a mass of prismatic trap, as to be often overlooked in walking along this shore, even by those who have been directed to the spot. It is accessible from below in one or two points, and the beach is strewed with huge fragments that have fallen from it. From its horizontal position, it has been by some called a bed; but, like trap in similar cases, it may with more propriety be considered a horizontal vein. The visible face is rudely prismatic, and about twelve feet thick; extending for about 200 yards, and terminating abruptly at each end. It is apparently conformable to the sandstone in which it lies; but whether rigidly so, cannot be discovered, as the faces of the cliff are obscured, both by the mouldering of the rocks, and by dispersed patches of vegetation. Like the sandstone, it inclines to the S. W. in an angle of about thirty degrees. Its texture is tolerably uniform throughout, being most commonly also lamellar, and it is of a dark, or bottle-green colour. It is not accompanied by any visible disturbance of the adjoining sandstone, nor is there any apparent change in either rock at the places of contact; except that, as happens so frequently among the trap rocks, the vein decomposes to a certain depth near the junction. In the land above these cliffs, not far from Dun Fion, many detached masses are also found; together with some that appear fixed portions, and may belong to other veins, or may possibly be connected with the large mass now described.

A better known and more conspicuous vein crosses the road in this place, where it is about thirty feet wide, passing through the sandstone strata. In this example, as in the former, no affection of the sandstone occurs where the two substances unite. The colour of this pitchstone is green and its structure lamellar; while it occasionally contains a few crystals of felspar so as to acquire a porphyritic aspect. It is tender and

easily broken when in a moist state, like many other rocks recently removed from the earth, but acquires a much greater degree of induration after some days of exposure to the air. Where in contact with running water, it decomposes into a tenacious clay; a thin coating of which is often found on the exposed surfaces, diminishing their natural lustre.

A large mass is to be seen by the road side at the corner of Brodick wood. This appears to be a wide vein; but is very short in its course and much inclined. A trap vein lies near it with an angular course, such as to indicate their probable junction; but the ground does not permit their contact, if it actually takes place, to be traced. The colour of this pitchstone is a bottle green, and its texture is porphyritic.

It is not unusual in this rock, to find some specimens, like many obsidians, presenting indications of an internal structure; consisting of laminæ imperfectly parallel, and generally waved and contorted. In the vein now described, no such appearance can be observed in a fresh fracture; but, like many of the trap family, it displays, on weathering, obvious indications of that which could not be conjectured by examining the unaltered rock. The exposed surfaces are found beautifully spotted with white, and marked with white curved lines, following each other in the conformable manner seen in certain varieties of marbled paper. The white spots in this case are produced by the weathering of the felspar; and, by this indication, many pitchstones are discovered to be porphyritic when the imbedded crystals can scarcely otherwise be observed. As the striped appearance is doubtless a result of the internal structure, it must proceed from the mixture of two substances, differing in hardness, or in tendency to decomposition; and as these marks are often bent and twisted in a variety of capricious forms, they seem to

prove that pitchstone, like basalt, has once been in a state of tenacious fluidity.

I observed another interesting circumstance in this vein; namely, imbedded nodules or fragments of the adjoining red sandstone; these being found in a part which is far distant from the including walls of that rock. This is the only instance, as far as I know, in which fragments of the including rock have been found in pitchstone veins, although an appearance not uncommon in trap; and it presents an interesting analogy between these two substances, in addition to those which are already well known.

Another vein of pitchstone of a dark green colour, is found between Garbin and Kilbride; and this rock occurs in loose masses, possibly portions of veins, at the head of Glen Scordel. A vein of the green variety is also to be seen in Came na Caillich; the only instance in the island in which it has yet been found in the granite; since, like trap, it seems chiefly to affect the secondary strata. There is however little reason to doubt that other veins exist in a similar situation; as I procured a specimen of a black porphyritic variety on Ben huish; and since, as will presently be seen, a very beautiful porphyritic variety occurs also in considerable abundance in Glen Iorsa. The various loose masses found in different parts of the island, are oftener green than black, and perhaps much oftener porphyritic than simple. Some of the black varieties approach very nearly to fine grained basalt. Of the porphyritic kinds, some detached masses are found in Glen Iorsa, not much unlike the well known rock of Egg; but of an aspect still more beautiful, and containing glassy felspar in a conspicuous proportion. Similar fragments are found on the beach below Screeb; but in neither case has any attempt to trace the origin of these loose masses been attended with success. As the sandstone does not occur in that part of Glen Iorsa where this

pitchstone is found, it must in this place either be derived from the schist or the granite, as I have already surmised; and it is equally probable that the masses found at Screeb have descended from the sides of Goatfell. There is a peculiarity in the mineral structure of this substance worthy of remark. The felspar crystal is sometimes a mere shell, containing a central body of the same pitchstone that surrounds it; and occasionally it appears composed of a succession of crystalline plates, a lamina of the rock intervening between each.

But the most remarkable and accessible collection of these veins, is to be seen at Tormore, already mentioned when speaking of the porphyry and the trap veins. The confusion of the whole place is so great, that it is very difficult to give a distinct account of it, or indeed to form a distinct conception of the disposition of the veins. Numerous detached portions are here scattered along the shore, originating possibly from veins which escape notice in consequence of the destruction of the cliffs and the accumulation of loose materials. But independently of these, there seem to be four distinct fixed masses belonging to two or more veins. The course of the first, commencing from the north of Tormore, is short, and its position is at angles to the sandstone strata, which are here horizontal. It is of a green colour, somewhat porphyritic, and of considerable thickness; but both its extremities are concealed by the ruins, and by other veins among which it is entangled. The second mass has a course still shorter, which is also at angles with the sandstone strata. It exhibits different characters in different parts. In general it is of a green colour and coarse aspect, with a porphyritic structure; but it alternates in an irregular manner, and in laminæ parallel to its sides, with a siliceous substance resembling both chert and chalcedony, which will be hereafter described in the catalogue of varieties. By decomposition, it presents on the

surface an orange brown stain in the places where this change of character occurs.

The third vein is much more remarkable. This runs in a S. S. W. course from the cliff for a considerable space, till it is lost in the sea. It varies in breadth from twelve feet to thirty, being slightly incurvated, and in some places appears somewhat conformable to the sandstone; yet, even in these, it forms an angle with the strata, dipping towards the east. The pitchstone of this vein is of a dark green colour, and is somewhat porphyritic, but variable in texture. Near the sea, it is accompanied on each side by a vein of chalcedonic chert, also slightly porphyritic; a circumstance much resembling that which occurs in the pitchstone of Egg, the chert vein there lying in the middle of the pitchstone.

The fourth and last mass is also of considerable extent, but is less easy of investigation. At first, nothing is perceived but a confused heap of detached blocks: a narrow examination however, shows that these are all portions of a single mass; the greater number of them, although detached from each other, being still *in situ*. This collection of fragments is horizontal or nearly so, and seems to be the exposed portion of a vein, conformable to the sandstone, and split into separate parts by exposure to the weather. In structure, it is perfectly identical with the smaller mass first described; showing the same gradual passage into chert, with the same orange brown stains.

On comparing these four separate masses, it seems probable that the first and fourth are portions of the same vein, which in one place cuts the strata and in the other conforms to them; the identity of structure being absolute. In the same way it seems probable, that the second is a portion of the third, the intermediate connexion, in both cases, being obscured by the incumbrances in their vicinity.

It is unnecessary to describe the several intersections which these veins undergo from the trap veins amongst them; as they offer no peculiar interest, and must be sufficiently understood from what has already been related: but before finally quitting this subject, a few remarks on the probable geological nature of this rock will not be superfluous.

In every situation but one in which pitchstone has yet occurred in Scotland, it is found in the form of veins.* It may perhaps be said that the horizontal mass at Corygills is a stratum, but the circumstance of position alone does not justify that conclusion. If that alone were sufficient to distinguish a stratum from a vein, no horizontal or conformable veins of trap could exist, whereas they have been proved to be common. It may perhaps be safely asserted that in almost every instance where a trap rock in a horizontal position is followed by a stratified rock, it is an intruding mass, and therefore a vein; and that the only instance in which trap can be viewed as a bed, is where it forms an overlying mass; since in no instance is there an example of any rock deposited on this substance, which, on the contrary, appears invariably to be itself the latest of all deposits. If there were no other points of resemblance between pitchstone and trap, the following fact alone would be sufficient to prove their analogy, and to establish the true nature of those masses which are conformable to the strata in which they lie. They are found in the secondary strata, in granite, and in the trap rocks; occupying thus a variety of position of which there is no analogous example except in the rocks of this latter family. No substance decidedly

* The exception to which I here allude is that of the Scuir of Egg, formerly described; but if it is an overlying mass it is plainly no obstacle to the supposed posteriority of pitchstone; it rather tends to confirm that view by strengthening the analogy between this substance and the trap rocks. It is not improbable that it may have been a vein in the trap on which it now stands; a notion strengthened by it's peculiar shape, and by the evident waste of the surrounding rock.

stratified has yet been found in positions so various; nor is there the slightest analogy existing to confirm the supposition that the same stratified rock should in one case alternate with the most recent strata, in another occupy veins in the overlying rocks of an origin still more recent, and lastly, occur in a similar manner among the most ancient unstratified substances.* But the geological identity of trap and pitchstone is confirmed by other circumstances in its composition and in its general characters. In the vein of Brodick wood, it was shown that it entangled fragments of the including sandstone; a fact highly characteristic of intruding veins, and well known to be of frequent occurrence in trap. It was formerly remarked that, in Sky, fragments were found near Loch Scavig, consisting of basalt passing into pitchstone; a fact of which the true nature is ascertained in the island of Lamlash, shortly to be described. In this case, a basaltic vein presents the same gradual transition into that substance, which is thus found occupying the walls of the vein to a certain depth, wherever these are in contact with that vein of trap which it traverses in its passage through the sandstone in which this latter lies.

In many instances indeed it is difficult to determine whether a given vein be basalt or pitchstone, so indefinite is the character; and, of this occurrence, examples were also noticed in Sky. Even in the Scuir of Egg, the character of the rock is often so indeterminate as to have induced observers to consider it as a transition between these two substances.

It is now necessary to describe the mineral characters of this substance under the several forms in which it appears in Arran. These are subject to many varia-

* We have indeed been informed that beds of pitchstone are known to exist on the continent of Europe. But as the authors to whom we are indebted for this information, consider all the conformable masses of trap as beds, it is evident that their opinions, in this instance also, may be the result of theoretical views.

tions, most of which are, in different respects, interesting; while many of them illustrate circumstances in the history of pitchstone that have either been overlooked or misapprehended. For these reasons the leading characters of the most remarkable varieties will be described; by which method the mineralogist will become more perfectly acquainted with this substance as it occurs in Arran, than by any minute description of two or three individuals. Those which I have selected for notice are the following:—

1. Uniformly small conchoidal in the fracture, and bottle green.*

2. The same, with minute grains of quartz interspersed.

3. Concretionary, simple, and of a bottle green colour; presenting great variety in the mode of breaking, or in the forms of the fragments. The following are the most remarkable:—

Spheroids or ellipsoids of irregular forms, varying from one to three inches in length, and from half an inch to two inches in breadth.

Columns of an irregular shape, some sides being flat and others round, from one sixth of an inch to one inch and a half in diameter, and reaching to five inches in length.

Prisms, square, triangular, or polygonal.

Lamellar concretions, straight or curved.

Columns, separating into joints with concave and convex surfaces.

These several structures pass into each other; and the lamellar, which are most frequent, are sometimes procured in fragments a foot long and six inches wide; their thickness varying from half an inch to an inch. This variety occurs only about Corygills.

4. Simple, of a bottle green colour, alternating with

* Leek green of some. The colour is nearly that of bottle glass.

lamellæ of a darker colour which appear on the surface like stripes.

5. Simple, with distinct alternate laminæ of black, and of dark or of bottle green.

6. Dark green and porphyritic. The imbedded grains are however not crystallized, but spheroidal; and, when large, present a crystalline nucleus, which gradually blends with the pitchstone by means of an intermediate enamel: when small, the enamel alone is found. In the most distinct specimens, these grains can scarcely be recognised for felspar, except by the change they undergo on weathering. This is by far the most common appearance of the pitchstone porphyries of Arran; and the resemblance to that of Glamich, formerly described, is so striking, that it is unnecessary to remind the reader of it.

7. The same with a thin schistose fracture.

8. Dark bottle green, also commonly enumerated among the pitchstone porphyries, but the grains are rounded and consist of quartz. They are white in the centre, but are surrounded by a brown crust, which has the aspect of chalcedony and appears to be a transition from quartz to pitchstone. This substance will be presently shown to occur on a much larger scale.

9. The same, with this variation; that the grains are disposed in thin layers alternating with equally thin laminæ of the pitchstone, being further often so condensed and united as to form granular continuous laminæ.

10. Pale greyish green, granular-conchoidal, and porphyritic in appearance; but the grains consist also of quartz. The quartz becomes gradually excluded in this case, and thus many additional varieties are produced.

11. Dark bottle green, containing grains of felspar so transparent as to be scarcely distinguishable on a fresh fracture. They are only discovered to be abundant after the rock is weathered; when they are seen, white, and thickly sprinkled over the surface.

12. Grey muddy green, granular, and glistening; but the fracture passing to conchoidal with a dull surface; when it puts on the aspect of chalcedony.

13. Obscure yellow green; breaking by the first fracture into conchoidal concretions with a smooth dull surface. These, being again broken, present a granular glistening fracture. This is a sub-variety of the former.

14. A mixture of chalcedonic chert and pitchstone, so intimate as to resemble a transition between the two till examined by the magnifying glass.

15. Simple granular-conchoidal, brownish green passing to brown, and presenting different sub-varieties.

16. Large granular, slightly conchoidal, of a yellowish brown colour.

17. Brownish black, small conchoidal-granular, and obscurely porphyritic.

18. Black, with a large flat conchoidal fracture; sprinkled with minute spots that appear at first sight to be imbedded substances, but are discovered by the lens to be small squamous fractures independent of the general one.

19. Black; the conchoidal and large granular fracture united; with rare and imperfect crystals of white glassy felspar.

20. Black and dark grey alternating in stripes, resembling in this respect some varieties of obsidian; minutely porphyritic, with a very large and perfect conchoidal fracture resembling that of glass.

21. Passing into a brown substance (hornstone of some) apparently intermediate between pitchstone and chalcedony, and interlaminated with dry chalcedony, (or chert,) and quartz. Botryoidal translucent chalcedony occurs in rifts in this variety. This transition is found in one of the veins at Tormore.

22. A transition into yellow brown chalcedonic chert, the hornstone of many authors.

23. A perfect transition into grey and into brown chert.* I have introduced these transitions here, although they cannot be considered as pitchstones, because they seem to be required for the illustration of the subject.

24. Dirty yellow green pitchstone, with opake and glistening parts intermixed, and containing numerous spherules, so as to be on the verge of pearlstone, if not actually belonging to this substance.

25. Dark green; minutely columnar and the columns separating into spheroidal concretions, many of which, perhaps all, contain a central atom of felspar; found loose on Ben huish. The approach of this to pearlstone, and its analogy with the pitchstone of Glamich, are both interesting and illustrative.

26. A beautiful porphyry containing large and numerous crystals of glassy felspar; the pitchstone basis being bottle green. The peculiar circumstances attending the felspar crystals were already noticed.

Many of the green varieties become of a pure white on decomposition, desquamating in successive thin crusts. These are opake, and generally earthy in their aspect; but are sometimes glossy, compact, and brittle, so as to resemble common white enamel. The natural green colour of the stone gradually disappears as the decomposition proceeds, as if it was produced by some decomposable or soluble matter. They sometimes become striped in the progress of decomposition, thus indicating an internal

* The term hornstone having become ambiguous, from its indiscriminate application to different substances, I have thought fit to reject it; the only remedy in all similar cases against future confusion. I am the more inclined to do this, because it was applied before minerals were as well understood as they are now, and because we are in possession of terms more accurate and less liable to misapprehension. All the specimens formerly known by this name, may be referred to compact felspar, or to chalcedony, or to chert, or to some transition between the two last substances.

structure; as I have more fully pointed out in describing the pitchstone vein of Brodick wood.

I SHALL now proceed to enumerate the few independent minerals which have been observed in Arran, the history of its rocks having terminated with that of the pitchstone.

It was already remarked that smoky quartz was found in cavities in the granite. The crystals sometimes attain a considerable size, and have been collected for ornamental purposes. The felspar found in the same situations, occasionally also attains sufficient size and regularity to find a place in the cabinets of collectors; in the porphyry of Drumodune, it also occurs in many distinct forms; the crystals being easily detached from the rock in consequence of the decomposition of the base. It is said that adularia is occasionally to be met with in the granite, but it did not fall under my observation.

Epidote is found in many parts of the island; entering into the schist, the granite, and the porphyries; but it is neither conspicuous for its beauty, nor for its quantity in any one spot. Augit, mesotype, and the sulphat of barytes were already mentioned in the places where they occur; and they present no interest to justify a more detailed notice. Stilbite, has been observed in cavities in the granite; in small quantity, and in minute crystals. It occurs in the same manner in Strontian mine; but excepting in these two instances, its place in Scotland is invariably among the trap rocks.

It was already remarked that the prehnite found in the augit rock of this island, was in very small concrêtions, but that it exhibited transitions into quartz, mesotype, (or nadelstein) and chalcedony. These transitions are very interesting, although here so obscure as not to present very satisfactory proofs of their real nature. But their existence is confirmed by the occurrence of analo-

gous appearances on a much larger scale in the prehnite of Dumbarton and Renfrew; and as these circumstances have not hitherto been investigated, it will be useful to describe them as they occur in those places.

A very extensive district of trap rocks is here found occupying both shores of the Clyde; conspicuous for the quantity of prehnite which it contains; that mineral being associated, as is not unusual, with many more of the zeolitic substances that appertain to this rock. The prevailing are, stilbite, nadelstein, and analcime: laumonite and ichthyophthalmite are more rare, and it is doubtful if mesotype exists; as it is occasionally impossible, without chemical examination, to distinguish this mineral from nadelstein when it occurs in minute nodules and passes to the opake state. In certain places, harmotome abounds, and it is scarcely necessary to add, that the nodules of quartz and of chalcedony so common in the trap rocks of Scotland, are also found in this. It is unnecessary to notice the other imbedded minerals, as they are not connected with the object at present in view.

The prehnite here exhibits three very distinct varieties of texture, or of aspect; being fibrous, lamellar, or presenting an even fracture which is either flat or imperfectly conchoidal. It is rarely crystallized; the most common form being that of a solid mass, with a tubercular or botryoidal surface in those places where the cavity which it occupied has been partially empty. These are at times so accumulated as to present stalactitical forms. Occasionally however, the surfaces of these tubercles are echinated with crystalline terminations, generally very obscure, but sometimes sufficiently distinct to give indications, at least, of the geometric forms which they seem endeavouring to assume. In a few rarer instances, independent but minute crystallizations may be observed; but the forms even of these are confused, either from aggregation, extreme minuteness, or want of geometric decision.

The colours are various, even in the different modifications; but tints of green are prevalent in all those which possess an ordinary or a medium character; while those which are at the extreme of either of the three textures, are commonly either white or colourless, according to circumstances that will immediately be stated. The green colour varies from the palest tints of yellow, ordinary, and sea green, to shades of considerable intensity; yet never attains a hue so strong and bright as that of the prehnite found at the Cape of Good Hope. Occasionally, it is evidently coloured by copper, although the general green tint appears to be independent of that substance.

In all these cases the prehnite continues to be more or less transparent, as it is also found to be when possessed even of a sap-green colour. But a variety, of a dark bottle green hue, also occurs, which, as it becomes darker, also becomes opake, and is generally intermixed with talc of the same tint.

Among the more transparent varieties, pale yellow brown is occasionally found, as well as pale grey; this latter modification, as it gradually loses its colour, becoming so transparent as to show the hue of the rock to which it is attached: in this case also the fracture resembles that of chalcedonic quartz, presenting no apparent internal texture. Purple brown passing to a more reddish purple is not uncommon in the semi-transparent varieties; and the colour sometimes gradually vanishes in the same specimen by an apparent dilution. The former colour is occasionally so intense as to produce a perfect opacity; and the specimens of this description cannot then be distinguished from the brown rock with which they are associated, except by a fresh fracture. In this however, it is easy to perceive the radiating structure of the globules which form the mass, which is commonly fibrous with a slight tendency to the lamellar, and either opake or glistening. These specimens also present at times a botryoidal surface; in which

case they might easily be mistaken for the globular varieties of siliceous schist occurring in the Shiant isles and elsewhere. In the last modification of colour which it is necessary to describe, the tints are disposed, as in natrolite, in zones parallel to the centre of the nodule; the different hues being white, green, and purple, forming a very ornamental mineral, and presenting yet another point of resemblance between this substance and a common member of the zeolite family.

The fibrous variety presents considerable diversity of aspect, all consisting in the greater or less perfection of the texture, as it proceeds in gradation from the solid modification, or vacillates towards the laminar. During this progress, its transparency also increases, being most perfect in those specimens which possess the fibrous texture in greatest perfection. In these cases it sometimes retains the usual green colour, but occasionally also becomes colourless; and thus some of the varieties are found to be glassy, fibrous, and transparent. In examining the botryoidal surfaces in these specimens, they present the terminations of square prisms, sometimes truncated at right angles by a surface either flat or convex; at others, bevelled on two opposed faces, also by flat or by curved surfaces, so as to form wedges, but generally too minute and irregular to admit of being easily defined. Occasionally however, the prisms are elongated and more perfect, although, even in these cases, they are accumulated into groups.

This variety therefore undergoes a gradual set of changes, in texture, colour, and transparency, by which it approximates to nadelstein. It is true that I have not in any instance discovered a complete and final transition into that mineral; but the interval remaining unfilled is not considerable, while, in many specimens, the nadelstein is associated with the prehnite in such a state of indiscriminate mixture, that the two cannot be separated.

In examining the lamellar variety, it will be found to undergo similar changes, according to the increasing perfection of its structure. During this progress the transparency also becomes more complete, while the colour occasionally vanishes, so as to present specimens of which the detached fragments are scarcely distinguishable from stilbite, which in these cases it also emulates by the gradual acquisition of the pearly lustre. The crystalline forms of this variety may be traced in the same manner on the surfaces, and they present the edges of square or octagonal lamellæ of which the edges are occasionally bevilled, but more generally unmodified. Cases also occur where the crystals of this variety are nearly detached; and these, however obscured by aggregation, bear a considerable general resemblance to the fasciculated prisms of stilbite. This variety therefore may be considered as presenting an approximation to that mineral, although in both these cases the rarity and imperfection of the crystalline forms prevents the geometrical connexions from being satisfactorily established.

In examining the solid variety, the first conspicuous change is that from imperfect transparency to a limited opacity, which gradually increases till it becomes absolute; the specimen in this case gradually also assuming a fracture indicative of a different geometric structure. In these cases the green tint vanishes entirely, the colour becoming white. This transition is found equally to occur from the fibrous or from the lamellar to the opake. The change of crystallization is here perfect, the forms being those of analcime; while the transition is so complete as to leave no doubt respecting the nature of such a specimen when detached from its original connexions. In some specimens a single spherule may even be observed, of which the one half is prehnite, and the other a part of a crystal of analcime. Prehnite is therefore a common bond by which these three minerals, otherwise associated by many peculiarities, are to a certain degree united.

I have not hitherto observed any marks to indicate a passage into laumonite, ichthyophthalmite, or harmotome. The analogy of the latter to the other zeolitic minerals, appears indeed to be comparatively inconsiderable; but various specimens occur which seem to point to a possible transition from the first of these substances into stilbite, and from the second into analcime; a mineral presenting so many diversities of character as to require a more accurate consideration than it has yet received. The arrangement of the zeolitic substances appears indeed still imperfect; as I have already had occasion to notice in speaking of the transitions which, in Sky, occur from nadelstein to chert and to quartz, and of the great diversity of chemical composition presented by analcime.

But these transitions into the zeolites are not the only examples of the varying character of prehnite. A distinct transition into quartz is by no means rare in the tract under review. In these specimens the centres of the aggregated globules consist of prehnite, commonly of a distinct fibrous texture. As the fibres extend from the centre they become harder and lose their green hue, becoming also colourless, and at length transparent; while they enlarge in such a manner as to represent accumulated prisms of quartz. The perfection of the change to quartz is, in this instance, as in the change to analcime, put out of doubt by the surfaces of the spherules being covered with large and distinct pyramids of transparent quartz.

I have not met, in this tract, with any decided examples of a change to chalcedony, unless the condition which takes place between the quartz and the prehnite may be considered chalcedonic; but such a change would excite no surprise, when it is considered how slight the differences are between that mineral and quartz.

In attempting to apply geometrical analysis to these varieties for the purpose of confirming the reality of those changes, no additional light is thrown on the subject; or at least no certainty can be procured respecting the

points of change. This might, a priori, be presumed; as the change of character is necessarily accompanied by those alterations which prevent definite fragments from being obtained, except at the perfectly characterized extremes.

But they are proved to be real variations of composition by chemical examination. Corresponding changes are thus detected in the proportions of the several earths which enter into the composition of the several varieties. It is plain that in such cases an analysis of a more accurate nature would be attended with intolerable labour, while it could lead to no determinate or useful results as to these proportions; and it is also evident that this view of the varying character of prehnite will account for the differences of the results that are obtained on analyzing it. Mineralogists will immediately perceive the consequences which hence follow, relating to definite proportions, or to definite geometric forms, as infallible characteristics of mineral species.

LAMLASH.

This small island may be considered a dependency of Arran, being associated with it no less in structure than in geographical position. At the same time, it presents some interesting peculiarities requiring notice, while the general simplicity of its arrangement will permit that notice to be very brief.

It consists of a single mountain rising to the height of 1009 feet, as appeared by the barometrical measurement, its length being estimated at a mile and a half, and its breadth at less than half a mile. The surface is generally rocky and covered with luxuriant heath and Arbutus uva ursi; scarcely any grass being found on it, except in the lowest situations. The access to the summit is in general difficult, and the acclivity considerable; on the eastern side, the mountain is inaccessible; the ground descending rapidly by a succession of precipices and steep slopes.

From the situation of Lamlash with respect to that sinuosity in Arran which it covers, it forms a convenient and capacious harbour. This is the most frequented of all the harbours in the Clyde; while from its double entrance, its magnitude, depth of water, and the quality and cleanness of the ground, it is esteemed one of the best in Britain; being equally adapted for ships of all burthen, and, from its capacity, adequate to the reception of large fleets.

The geological resemblance of Lamlash to Arran is limited to that part of the latter island immediately opposite, namely, the southern division; which has been shown to consist of secondary strata covered and intersected by various rocks of the trap family. Like this tract, it contains neither granite nor primary strata.

The sandstone may be seen in different places, and in

positions generally similar to those which it occupies in the greater part of Arran, namely, very little deviating from the horizontal plane. The most extensive range of strata is found at the northern and lowest parts of the island; where their broken edges are visible in many places, and particularly in that portion which faces the town of Kilbride. Hence they extend round the base of the mountain towards the southern extremity, for about two-thirds of its length. The only other conspicuous mass of this rock, lies on the east side, under the most elevated and steepest part of the mountain; since, although it is to be seen in various places round the southern side of the island, it no where else occupies any considerable space without interruption. This portion extends continuously along the eastern shore for more than half a mile, often presenting solid and uninterrupted faces of 150 feet or more in thickness. One part of it in particular is remarkable; forming a perpendicular cliff which overhangs so far as to admit of a passage behind the streams of water that in wet seasons are continually dripping over its high edge. Being uniformly curved, it reflects sound in a remarkable manner; producing those distinct echoes that occur in works of art under similar circumstances.

In the general details and mineral characters, this sandstone resembles so exactly that of Arran, as to render a minute description unnecessary.

On the western side of the island it is uniformly red. The principal part of the mass on the east side, is of the same colour; but as the dip is here northerly, a lower set of beds becomes exposed in proceeding towards the south, of a white colour with a slight ochrey tinge. It will be remembered that the same circumstance occurs on the north-eastern shore of Arran; the white sandstone to the north of Sannox, being inferior in position to the red which appears at the Cock. It was shown that the former is interposed between two leading masses of the latter; and the same alternation probably exists in Lam-

lash, although rendered invisible by the positions of the beds with respect to the sea, which excludes whatever may lie below the white strata. Fragments of conglomerate are found scattered on the shore, indicating that some of the beds possess this structure. Occasionally, the white sandstone contains rounded pebbles of trap, and not unfrequently, when in the immediate vicinity of the overlying rock, presents that indication of a crystalline tendency which was formerly described as occurring in similar situations near Blackwater bay.

The sandstone beds now described are covered by a mass of felspar rock which constitutes the chief part of the island. Its greatest thickness may be estimated at 800 or 900 feet, taking it from the point of contact with the sandstone to the summit of the mountain. This mass appears, on a general view, to be disposed in regular beds following these strata in a conformable manner; and, without a careful examination, would be pronounced a parallel and alternating rock. But on the eastern side, it will be seen in one place to intersect the whole body of strata; the intersecting portion being connected with the more extensive overlying one, in the same manner as it is in different parts of Arran. The sandstone is in this place found abruptly terminating against the former portion, yet the junction is not attended by any peculiar disturbance. The accompanying sketch will render this circumstance more intelligible than any description. *

In the lower parts of the mountain, the natural fracture of this rock is vertical and prismatic, resembling that of the obscurely columnar traps. Many faces, presenting this character, and varying from 20 to 150 feet or more in height, are visible on the eastern side of the island. On the summit, it is found in a schistose form, similar to that already described as occurring both in Mull and in Arran;

* Plate XXIV. fig. 2.

and although the combination of the prismatic and schistose fractures is not so decided here as at Corygills, it is nevertheless to be observed in different places. Wherever it is found, the ends of the columns first divide into imperfect laminæ, and at length the mass loses the columnar aspect and becomes continuously slaty.*

The mineral characters of this rock are similar to those of the corresponding substances in Arran, but offer rather less variety. It passes from a clinkstone to a hard claystone, often by a very gradual transition; and is remarkable for the great depth to which it is sometimes affected by the action of the weather. This change consists chiefly in the substitution of an arenaceous for a compact fracture, and of an arid for a translucent surface; being accompanied at the same time by a change of colour; the grey varieties becoming yellow, or white, or presenting different successive zones of these tints. Nothing can be added on this subject to the few remarks that were offered when formerly treating of the Slate isles; and I may conclude the description by saying that it presents considerable varieties of colour, namely, whitish, ochre yellow, dark lead-blue, smoke grey, and purplish grey.

It has been seen that the trap rocks occur in Arran, both intermixed in distinct portions with the rocks of the felspar division, and overlying them. None are found in Lamlash occupying these situations; all those which are here visible, being either ordinary veins, or masses involved in

* With respect to the schistose rocks of this family, whether simple or porphyritic, it is proper here to remark, that in no instance which has yet occurred in my observation, can the schistose division be effected by force. Neither does it appear to be found in the deeper parts of the rock; being, on the contrary, limited to the surfaces, or to a small depth beneath. It would therefore seem to be the result of an incipient decomposition, and, as remarked in Arran, is analogous to that which takes place in certain varieties of granite. It is important to observe, that it is very distinct in every respect from the schistose structure as it occurs in the argillaceous slates.

the sandstone strata, and equally appertaining to the class of venous formations.

The principal of these masses are found towards the south-eastern end of the island; and, if a cursory view only, be taken of their connexion with the sandstone, it would be concluded, as it has been by some observers, that the trap was inferior to the strata and the felspar rock superior; the whole forming a regular series. There appears, indeed, at first sight, to be a regular alternate stratification of the white sandstone with the trap, the latter rock being the lowest. This alternation is frequent, and the thickness of the different beds, although variable, is seldom considerable. But if the details be carefully examined, there will be no difficulty in perceiving that the trap is intermingled with the sandstone in irregular portions, and not in continuous and parallel beds. In one place it may be observed to terminate suddenly, while, in another, the sandstone is cut through by the meeting of two neighbouring masses of the trap. It must therefore be considered as offering examples of those horizontal veins which have been already sufficiently described on various occasions. In composition, this rock is identical with that occurring in Arran, near Clachland point and elsewhere; containing augit, felspar, and mesotype: if there are any variations, they seem to consist in the greater or less distinctness of the component parts, and do not require any particular detail. It is proper to add, that here, as in similar situations, the sandstone is much indurated near its contact with the trap. This is particularly the case with a large portion of conglomerate that occurs in the neighbourhood of the pitchstone about to be described.

Besides those just mentioned, other masses of trap occur in similar positions towards the southern extremity of the island; but these, with one exception, are not attended, as far as I could perceive, by any remarkable

appearances. That portion alone is conspicuous as containing the pitchstone vein; but the accompanying drawing will supersede the necessity of any description of it.*

With the exception also of one vertical vein of trap, which is seen in the same drawing, it seems unnecessary to notice those which occur in Lamlash, as they are attended with no interesting appearances. That example is remarkable for its spheroidal structure; a circumstance rarely found in those veins.

The pitchstone above mentioned, which is also represented in the drawing, is disposed in a manner of which no analogous example has yet occurred throughout this survey, and offers some interesting peculiarities.

The alternation of rocks found at this place, consists of sandstone, trap, conglomerate, and clinkstone; the sandstone, which regulates the position of the rest, dipping northwards in an angle of about twenty degrees. The vein of spheroidal trap intersects the whole of these rocks, and is accompanied at no great distance by an upright vein in a parallel direction, which can however be traced only through the mass of horizontal trap. There is much confusion about this place, occasioned by the fragments of conglomerate and the fall of rubbish; while the form of the cliff, requiring both hands and feet to preserve the spectator's position, renders it impossible to examine the appearances with all the care that could be wished. Some favourable change in the state of the ground may, perhaps, allow of free access hereafter; but, in the meantime, no error will be occasioned by assuming the latter vein as thus limited, since no conclusions will be drawn from this assumption. It varies from a foot to six inches in breadth. Where widest, the middle portion consists of a fine and compact black basalt, containing occasional particles of

* Plate XXIV. fig. 2.

analcime, mesotype, and glassy felspar. On each side there is a lamina consisting of a black substance intermediate between basalt and pitchstone; gradually passing into perfect pitchstone at the surface where it is in contact with the trap. In this part it is of an intense black colour and vitreous aspect, but forms a mere crust, scarcely amounting to one-tenth of an inch in thickness. There is in this case an obvious line of separation between the outer laminæ on each side and the central basalt. In the thinner parts of the vein, there appears to be no central basalt, a regular transition taking place from each side to the middle; the former being of perfect black pitchstone, and the whole interior consisting of the intermediate substance just mentioned. The resemblance between these parts of the vein and the pitchstone of Egg is very strong; and in that, it will be remembered, the black pitchstone is found only at the sides of the vein; the central parts, wherever it is sufficiently wide, presenting an intermediate substance, differing, it is true, in colour from this, but resembling it in every other particular.

Whatever conjectures may be formed respecting the cause of this singular appearance, it is as yet too insulated to afford legitimate grounds for any conclusion. The passage of basaltic veins through basalt or other trap rocks, is by no means uncommon; and numerous instances can be pointed out through the whole of the trap districts of Scotland, unattended by any indications of a similar change. Hereafter, when a greater number of facts shall have been collected towards the history of pitchstone, this example may acquire additional value.

It was already noticed in treating of Arran, that blocks of the granite of Goatfell are found scattered over the shores of Lamlash; but I need add nothing to the remarks then made on the migration of these blocks.

I may conclude the history of this island by mentioning

that marle occurs on the shore opposite to Kilbride, apparently formed of fragments of sea-shells and madreporites. This circumstance may also be observed in Bute, and in other places where I have thought it unnecessary to describe it. In all the cases it appears to have resulted from the retiring of the sea, and to consist of those accumulations which once formed the sandy shores.

SANDA.

This small island, composed merely of sandstone, is among the least interesting of the islands of the Clyde. It is situated at a short distance from the Mull of Cantyre, and is accompanied by two smaller islets of similar aspect. It is of an irregular figure and about three miles in circumference, forming a single sheep farm and covered with excellent grass.

The remains of the chapel, dedicated, like most of the religious edifices of the Western isles, to the favoured saint, Columba, are still visible; together with two crosses of rude design, and various grave stones; some of the latter being sculptured with the atchievements of their long peaceful tenants. Its ancient importance, as the station of the Scandinavian fleets during the contests for the possession of Cantyre and the neighbouring islands, is well known; and the anchorage is still frequented by the smaller classes of vessels which navigate the Clyde. The burying ground is still an object of mysterious fear to the sailors who resort to the harbour for refuge; the remains of an elder tree being pointed out, over which whoever shall walk, is doomed to die before a year expires. Seamen are pertinacious records of traditional superstitions.

Like most other repositories of the dead throughout this country, the burying ground of Sanda presents every mark of neglect, being unenclosed, and covered with weeds and rubbish; the grave stones broken and defaced, and every thing bespeaking the want of that affection and respect which, among civilized nations, is so generally bestowed on these memorials of departed friends, and which is not uncommon even among nations in a very rude state. The contrast between the burying grounds of the Highlands and of Wales, is striking to

those who have witnessed the affectionate attention with which, in the latter country, the graves are preserved and adorned with flowers; a practice not unknown to ancient nations. Even the enclosed mausolea of the higher and more opulent families, often bear the same marks of neglect; being frequently dilapidated and overrun with weeds, the doors destroyed, and the inscriptions defaced by the tread of cattle. The whole is indeed in unison with the negligent and repulsive manner in which the funeral is usually conducted; the ceremonial, if ceremonial it can be called, producing, in those who have never before witnessed it, a strong impression of the levity with which the death of a friend appears to be contemplated; and the feeling, however unfounded, that with this act, every thing is here esteemed to be terminated. The frequent expense, and its misapplication, are no less offensive; that which ought to excite far other reflections being too often the excuse for a riotous festival. The present practice must perhaps, however, be considered as the consequence of innovation. The respect still paid to the cairn and the monumental stone, evince the habit that once existed among the ancient Celts; and the care with which these memorials were formerly constructed, proves that the Highlanders have not always been deficient in those feelings which, if they cannot benefit the dead, are not useless to the living. At present, while the body is thrown into the ground and forgotten, the nettle and dock supply the place of the rose, the area is unenclosed, or, if once enclosed, the walls are in ruins, the ancient tombs are destroyed, and indiscriminate neglect surrounds every thing. This effect of excessive reformation, if, in the Highlands, the present negligent practice has originated in that cause, is now counteracted in the Lowlands by the recovery of feelings more natural; and, although defective in those religious rites of which the

absence is to be regretted, the funeral is still conducted with appropriate decency.

The structure of Sanda corresponds precisely to that of the opposite shores of Cantyre; and, as in many other similar situations, the geological continuity of the strata between the two, serves to indicate the alterations which have taken place in the sea line, and the encroachments of the ocean on the borders of the great æstuary of the Clyde. The analogy in this respect between Sanda and the other islands of this firth is very obvious.

The sandstone of which it is composed, is elevated to the north, the dip being to the southward and varying from fifteen to twenty degrees. It thus forms hills of about 300 feet in height, which, on some of the shores, are broken into cliffs of moderate elevation. One of these, forms a very picturesque object, presenting a natural arch of considerable dimensions. The rock is reddish, and grey, and is interstratified with slaty clay of various colours, but chiefly of a grey hue. It is accompanied by beds of conglomerate similar to those already described, and by a sandstone containing fragments of clay slate, exactly resembling the well known rock of Kingudie in Perthshire, so largely used in buildings in the vicinity of London. The structure of Sheep isle, and of the accompanying rocks, is precisely similar to that of the principal island.

PLADDA.

PLADDA* is a very small and low island, more conspicuous for its light-house than for any thing interesting in its geological features. It would scarcely have required notice but for its connexion with Arran, and for the blank which its absence would leave in the mineral history of the islands of the Clyde.

The stratified rocks, which must be considered as forming the foundation of the whole mass, may be seen for a small space towards the eastern extremity, and they consist of a white sandstone accompanied by limestone. There can be no hesitation in admitting that these are continuations of the strata of Arran, and it is therefore superfluous to describe them further.

These strata are covered by a continuous bed of trap, which forms by far the greater part of the island, and reaches to the sea on almost all sides, so as to exclude their prolongations from sight. The surface of this bed is flat, and the edges present vertical and somewhat prismatic fractures; a feature common in Bute, but rarely occurring in Arran. The nature of this rock is in most places such, that, like many others described in various parts of this work, it scarcely admits of any very definite appellation, although a common substance, and found indifferently both in veins and overlying masses wherever it occurs. It cannot be considered a greenstone, since it wants the requisite distinctness of parts; although, like most of the trap rocks of this character which are not decidedly basalt, it has frequently been designated by that appellation; a term rendered vague only in consequence of its misapplication. The rigid manner in which the term basalt has been limited,

* Pladda, from Plade, a plate, Danish; a very characteristic term. —See the Map of Arran.

prevents it from being classed with this rock; although it is in many cases impossible to determine the boundaries of this species, if that may be called a species which is in a state of continual fluctuation, and is occasionally found passing into every other modification ranked under the comprehensive term of trap. It will be more safe to consider it as consisting principally, perhaps in some cases entirely, of an indurated claystone highly charged with protoxide of iron. If there be a darker substance intermixed, it is too minutely divided to be ascertained in a satisfactory manner by the eye; nor do these rocks admit of that mechanical analysis by trituration and washing, which has in some cases been successfully applied to mixed substances. But it is unnecessary now to enter into minute details respecting these rocks. To distinguish the variations which they undergo, even in so small a space as that which they occupy here, would lead to protracted descriptions from which no advantage could result to science, and no interest be derived in a topographical view.*

* The nature of basalt is a frequent source of difficulty, and must necessarily remain so till some acknowledged authority shall decide on a limited distinction; if one is necessary. The term seems at present applicable to the black or very dark indurated claystones, or clinkstones, to intimate mixtures, of augit, or of hornblende, with the same substances, and, apparently also, to hornblende alone when of a very fine granular and condensed texture.

On re-examining a fresh and more extensive collection of the rock of Staffa, I am in doubt if its nature was correctly stated in the preceding article on that island. The specimens in question, at least, seem to be a uniform substance, of one ingredient only, which is a granular splintery material resembling clinkstone, highly coloured with iron, but of a greenish black hue.

BUTE.* INCHMARNOCH.

THE geographical chasm by which Bute is separated from the promontories of Argyllshire among which it lies, is so small, and the general correspondence of character between the two so accurate, that neither in the map, nor in viewing it from the surrounding country, is it easy to distinguish it from the mainland. Together with this general resemblance, it corresponds so intimately with the adjoining district in geological structure, that the description of its rocks will equally serve for that of the neighbouring tracts, even throughout a considerable space. Independently of the numerous interesting circumstances which Bute presents, it is also of material assistance in uniting by a common bond the geological history of the islands of the Clyde, and in connecting their structure with that of the continent; combining together a variety of scattered, and apparently insulated facts, into one [redacted]hole. It is also peculiarly valuable in eluci[redacted]parts of the history of Arran, which are [redacted]obscure, as much by the local irregularities so [redacted]picuous in that island, as by its more distant position from the mainland, and by those peculiarities of structure in which it differs from all the surrounding country.

The length of Bute is about eighteen miles, and its general breadth may be taken at four, exceeding or falling short of this occasionally by one mile; the two sides, one of which faces the north-east, and the other the south-

* According to Shaw, Buta signifies a ridge. His dictionary however is compounded from all the dialects of the Celtic, and the Highlanders assert that Buta is not Gaelic. That need not vitiate a local etymology like this; as names of places are to be found in Scotland formed of that Celtic which was the common parent of the Welsh and Gaelic dialects; although these words are no longer in use in the Highlands as parts of the current language of the day.—See the Map of Bute.

west, maintaining a general parallelism. In these respects, its outline conforms to those of the proximate coasts of Argyllshire, and to the boundaries of Loch Fyne and Loch Straven; those outlines appearing in all these instances to have been determined by the forms of the ridges of hills, which are also composed of similar materials, both on the mainland and in this island.

Bute is naturally divided into three portions, not more distinct in their general forms than in their mineral structure.* The Garroch head consists of a ridgy and rugged group of hills, rising in different places to an elevation which varies from 600 to 800 feet, and composed almost entirely of trap rocks. This is separated from the middle district by a narrow tract, very little elevated above the sea, which is formed of alluvial matter and vegetable soil. The middle portion is an undulating land, scarcely attaining in the highest parts an altitude of 300 feet; composed, with slight exceptions, of sandstone, and divided from the third and northern tract by a low valley which extends from Rothsay to Scalspie. The northern district is formed of various primary rocks [redacted]histose structure: but these divisions must be exami[redacted]er detail.

The district last mentioned, consists of various det[redacted] hills, associated with one predominant ridge which stretches from the north-west point of the island to the valley that separates the bay of Etrick from Kaimes bay. This valley is but little elevated above the sea; and, like the two already described, it intersects the island in a somewhat transverse direction. The principal ridge occupies the eastern side of the island almost uninterruptedly; extending from Kaimes castle to within a short distance of the Kyles, and declining regularly to the sea on that side; while, on the western, it reaches the shore by a set of lower elevations. For want of accurate measurements, its height is estimated at 1000 feet; and this also is the

* Plate XXII. fig. 2.

greatest elevation which Bute presents. The outline of this ridge is, throughout nearly its whole extent, smooth and unbroken; but it terminates at the northernmost extremity of the island by a number of irregular hills of less elevation; crowded together and intersected by small valleys variously transverse to the principal bearing of the ridge, and presenting broken and rocky escarpements. The same irregular arrangement prevails in the tract included between the bays of Etrick and Scalspie on the one side, and those of Kaimes and Rothsay on the other. The highest elevations of the hills in this tract are equal to those in the portion last described; but while the summits are more detached, the tendency of the valleys which separate them is still transverse to the position of the main ridge, and to the general outline of the island. The hills of this division are also marked by the ruggedness of their outlines, and by the quantity of naked rock which they present; features by which they are conspicuously distinguished from the high tract immediately adjoining. From these circumstances it would be natural to expect, either the positions of the strata, or the nature of the substances which form these two portions of the primary division of Bute, so differing in character, to be in themselves different: but the geologist who must lay down the plan of his investigations in every unknown country, from indications of this nature, and must act on probabilities founded upon these and similar appearances, will, in this case, find them to be fallacious guides. The future geological details will show, that the whole of these rocks, if not of similar, are of analogous composition; and that the changes which actually take place in them, are in no respect correspondent to the variations in their disposition and general outline. A still more remarkable circumstance attends them. Whatever varieties of composition occur throughout the whole of this primary district, or whatever the direction of the valleys and ridges may be, the direction and dip of the

schistose strata of which the whole is composed, are always the same; if we except the very few capricious variations which are rarely altogether wanting in similar cases. This direction is to the eastward of north, and the dip is to the southward of east; being commonly at a high angle, but varying between twenty and sixty degrees. As the bearing of the main ridge, and the parallel outlines of the island, are north-westerly, the direction of the strata is consequently neither parallel to these nor transverse, but at an oblique angle: while, at the same time, it is occasionally either parallel or transverse to the other elevations which are not coincident in direction with the principal one.

It is so seldom that we are enabled very unquestionably to compare the directions of the strata of primary rocks with those of the ridges and groups of hills which they form, that it is proper to notice them whenever they can be ascertained. Such remarks may be useful in preventing us from concluding too hastily, that the forms of mountains necessarily depend on the position of their strata; since in this case it is apparent, [illegible] while the direction and dip continue to be the same, a[illegible]re of the rocks identical, every possible form, a[illegible] variety of position and outline, occur in the mountains [illegible] are composed of them.

The separation of the primary from the secondary district, takes place, as before remarked, in a low and narrow valley extending from Rothsay to Scalspie bay; and is accurately defined by two small fresh water lakes which occupy that valley, and by the streams that flow from them on each side to the sea. The largest of these, Loch Fad, is about a mile and a half in length, and the least, Loch Stuck, about half a mile. The junction of the two classes of rock at this place, is to be considered as a continuation of that principal and extensive line on the mainland, which may be traced from the eastern sea; but it varies here in some particulars from the general cha-

racter which it exhibits throughout that line. In most places the sandstone strata are elevated to a high angle; generally forming a subsidiary ridge of hills reposing against the primary. Here, they seem to be depressed, and to dip toward the west in a direction opposite to that of the primary, instead of being elevated against them. Hence the actual junction is invisible; the low valley where it takes place being overwhelmed with clay and soil.

There is little to add to the general sketch, already given, of the form of the land in this division. Round the primary tract, the shores are almost every where low; scarcely any decided cliffs occurring, and a flat margin, as in Arran, along which the road is conducted, forming the whole eastern side. To the south of Rothsay, there is a similar flat, answering the same purposes; within which the sandstone and conglomerate form a range of cliffs, of little elevation and small extent. The remainder of the shores of this division on each side, as far as the isthmus that separates it from the Garroch head, are generally low. Two or three trifling valleys intersect it on the eastern side, giving rise to small brooks; the little lake of Ascog occupying a portion of one of them: but, with these exceptions, the land possesses no remarkable features. The accompanying section, although an ideal one, will convey a better notion, both of the general form of the island, and of the various divisions enumerated, than can be communicated by words alone.*

The peculiar nature of the low tract which separates the sandstone district from the trap division of the Garroch head, gives reason to suppose that the sea once flowed between these two divisions; an opinion derived partly from its present extreme lowness, and partly from the nature of the substances of which it is composed. These

* Plate XXII. fig. 2.

materials are, banks of coral sand, the clay and sand produced from the wearing of the secondary strata, and an accumulation of vegetable matter in a progress towards the formation of peat, which is found in a portion of marshy land that occupies a part of the flat. Were these removed, the sea would again flow through the passage and restore the insular character of the Garroch head.

This last division, which I have already shown to consist chiefly of trap, is characterized by a remarkable disposition of ground. It is divided into a number of parallel and straight narrow valleys, of which a principal one traverses the entire extent of the promontory; the whole of these being disposed in lines from north-west to south-east, in a direction conforming to the general bearings of the island. These valleys are separated by ridges of the trap rock, of different lengths and elevations; and produce a very singular appearance when viewed from a commanding position. The escarpements, with very slight exceptions, lie in a prolonged line, and face the north-east; while the declivities, inclined at angles varying from ten to fifteen degrees, look to the south-west.

The scenery of this part of the island, without being strictly picturesque, is nevertheless pleasing, as well as singular in character; while, in many places, the unexpected solitude of its deep recesses is accompanied by a proportionate degree of grandeur in the elevation of the high rocks by which they are bounded. These minor scenes are however lost in the superior magnificence of the view from Ben varagen, the highest summit of the Garroch head; which extends over the whole complicated region that forms the boundaries of the Clyde. A few wooded and cultivated spots are seen in this division; but the higher parts, as might be imagined, are occupied in pasture.

The middle division of the island is, generally speaking, in a state of cultivation, and is tolerably wooded; the plantations of Mount Stewart forming a tract of rich

ornamented land not often surpassed even on the mainland of Scotland. The valley which separates this division from the northern one, is also woody; and is rendered picturesque by the rugged forms and height of the hills which bound it to the north; as well as by the very pleasing lakes already described which occupy so large a portion of its extent. The town of Rothsay yields to few places on the coast, either for the retired beauty of the situation, or for the magnificence of the mountain scenery which bounds the horizon; while its interest is enhanced to the painter, as well as to the antiquary, by the picturesque remains of its ancient and royal castle.

The small bay of Kaimes, and the valley which opens from it, present scenes of a similar character; while the long tract to the northward is occupied by a high range of pasture land, containing a few farms scattered in interesting situations along its sides; but owing more of their attraction to the views they afford of the mountains and lochs of the mainland, than to their own peculiar positions, or to the forms of the land surrounding them. The beauty arising from these circumstances, still increases in proceeding northwards, and in approaching nearer to the Argyllshire coast. Few scenes exist in the Highlands of Scotland of a more romantic character than those which occur in the narrow passage of the Kyles, which presents, throughout, a labyrinth of promontories, rocks, and islands. While the navigation is peculiarly intricate, at every turn all further progress seems to be denied through the intricate combination of land and water; the sea winding among broken rocks and woody shores, or under overhanging cliffs and lofty mountains; and appearing to have usurped the place, as it has adopted the characters, of an alpine river.

It is almost unnecessary to say that with one of the mildest climates of Scotland, Bute is also one of the most rainy. But the forms of the hills and the consequent

short courses of the streams, necessarily limit these to mere brooks, incapable of producing any conspicuous effects on the form of the surface. This island is indeed remarkable for the almost total absence of alluvial matter, except in the two places formerly mentioned. One or two banks of gravel are visible on each opposed shore, near the northernmost point; but whether these have been thrown up, under some former state of things, by the action of the tides, being afterwards deserted as the water has found a deeper channel; or whether they are the remains of more considerable deposits, now nearly removed by its gradual corrosive power, it is impossible to determine. No rolled stones of large size are any where to be seen; nor are there any deposits of loose materials in the interior valleys, except those which appear to have resulted from the wearing of the present surface. These, consisting of clay and sand, are found chiefly in the sandstone district; and are precisely similar to those which are seen in similar situations in Arran, and indeed every where else on the surface of this rock. It is unnecessary to take further notice of the flat tract near the Garroch head; and it is equally superfluous to describe the marly deposits which are found among the clay, as they evidently owe their origin to the occasional presence of calcareous rocks among the sandstone beds.

As the general boundaries of the primary rocks have already been described, and as they are particularly detailed in the map, it is unnecessary to dwell on them; the more so, as they do not present any irregular portions incapable of being specified in that map, and requiring verbal description. The dip of the strata is toward the east, as already mentioned, at various, but commonly at considerable, angles, the ordinary extent and irregularity of which have been noticed in the description of the mountain range. Any further remarks on the bearings

and general characters of these strata are for the same reason equally unnecessary.

But in mentioning the dip of the schistose strata, the question will naturally arise, by what criterion the stratification is distinguished; since, as I have formerly remarked, there is often a difficulty in discriminating between the schistose lamina and the stratum. As this question is however discussed at some length in the account of the Isle of Man, I shall here simply describe the circumstance by which the stratification can be determined in this place; when it will be seen to coincide with the schistose tendency. It is the same criterion by which the opposed position of these two is proved in the island just mentioned, namely, the alternation of substances; which here takes place in a direction parallel to the schistose lamina, whereas, in that island, it is found in positions variously transverse. The several substances will be particularized in the course of the description.

It will be remembered that in describing the schistose rocks of Arran, it was found necessary to refer to this island for a fuller explanation of many circumstances relating to them, which their condition in that spot afforded no means of understanding. The same difficulty exists in a less degree, even in Bute; although the position of the rocks is here consistent with that which they maintain on the mainland, and not, as in Arran, perverted by the intrusion of granite. The obscurity in this case arises from the great number of substances which occur among the schistose strata, and from the gradation and intermixture that take place among them; in consequence of which it becomes difficult, if not impossible, to ascertain their true relations to each other. This difficulty is increased by the narrow limits of the space which they occupy; since that which appears to be confusion when it is supposed to be partial, becomes a system of order when found to prevail as a general characteristic, and to extend over a large space. It will indeed be seen,

when the description of these rocks is given, that the obscurity and confusion here existing is, as in many other cases, of an artificial nature, and the result of a preconceived regularity that has no existence in nature.

From these circumstances it becomes necessary to give a general sketch of the nature of the schistose rocks of Bute and Arran, as they occur on that prolonged line which stretches through the mainland; which was already mentioned, in treating of the latter island, as being continuous in geological structure with the analogous portions of both. The structure of Bute will thus become immediately intelligible; while the general interest of the facts will be increased; although at the risk of transgressing on the province of those who may hereafter undertake the description of the continental rocks.

In an account of the chlorite [illegible] these consisting of clay and [illegible] of Argyllshire, it was shown that a tract of micaceous schist succeeded it towards the south, being continued in that direction as far as the Mull of Cantyre. At that place, it is immediately followed by the red sandstone, without any interposed substance; a fact easily explained by considering the unconformable relation of this rock to the primary strata, and the irregularity of its margin consequent on the peculiar situation which it occupies with respect to these. The same schist may be traced from this peninsula, as far at least as to the mountains of Mar; beyond which it is not necessary for the present purpose to examine into the structure of the mainland. The direction of the beds throughout the tract which it occupies, is in a general sense north-easterly, and parallel to the southern limit of the series; subject to the usual irregularities which have so often been mentioned. A great variety of dip will be seen to exist through this tract, if the whole space be examined; but on the southern margin, or boundary of the series, the inclination will generally be found toward the south-east. That boundary may be traced, in the direction already mentioned, from

the hills of Angus to the Clyde; passing through Dunkeld, Crieff, Callander, Loch Lomond, and other points which it is unnecessary to enumerate, through Bute; where it is indicated in the accompanying map of that island. This place is the last in which it appears with that linear regularity which it has so long preserved; the direction being perverted in Arran, although the series is there found, by the circumstances already stated in the description of that spot.

Throughout the line now described, the micaceous schist is not conterminous, as in Cantyre, with the red sandstone which occupies a parallel belt to the southward; but is immediately followed by another primary series, already noticed in Arran, and indicated in the map of Bute; where its true position, and its continuity with the remainder of the same series in the mainland, are preserved. The breadth of this belt of schistose rocks varies in different parts of its course; being sometimes extenuated to half a mile or less; in other places amounting to, or even exceeding five miles. In all situations, it follows the preceding series with a general conformity of inclination; and the linear direction of the beds is also parallel to that of the whole belt, or to the general direction of the primary strata of the Highland division of Scotland. Of both these divisions of primary rocks it may be remarked, that the quantity of the dip is various, but that the angles are generally high; rarely subsiding to thirty degrees, and often approaching the perpendicular. The general description of the last belt of primary rocks, will be terminated by remarking that it is immediately followed, and generally in an unconformable position, by the red sandstone; as is also indicated in the map of Bute.

It is unnecessary to detail the mineral characters of the varieties which enter into the series of micaceous schist along this tract, as it would transgress the bounds of the present discussion. But it is proper to remind the reader of that which was formerly noticed, namely, that

it frequently passes into chlorite schist, or at least approximates to that substance; the mica acquiring a greenish hue and a more tender texture. This change is most remarkable on the western extremity of the boundary; and it will also be found to predominate through Argyllshire, and even to a greater distance, in the north-easterly direction, until it ultimately ceases.

The characters of the external belt of primary strata have been cursorily mentioned in treating of Arran, but they will require a more detailed description. That is rendered peculiarly necessary, not only by their importance, but by their unexpected nature; if that may be considered unexpected where the opposite expectations have arisen from systematical views or from imperfect observation. It will be convenient to distinguish this by the title of the argillaceous series; as the presence of argillaceous schist forms one of its most characteristic features.

The substances which occur in this series are the following; micaceous schist, chlorite schist, clay slate, and graywacké; each of them presenting variations that will require some additional details: to these may also be added limestone, although this appears to be rather an incidental than a necessary member.

The micaceous schist presents many of its more usual varieties, but it occurs also under a form in which, as far as I know, it is not found in any other place than on the confines of the argillaceous series. This variety is characterized by the distinctness of the quartz grains in its composition; consisting, in fact, of an aggregate of sandy or gravelly particles united by scaly mica; and resembling in texture some varieties of graywacké. The grains vary in size from that of a pin's head to a quarter of an inch in diameter; but the several sizes are never intermixed in the same place; each distinct portion presenting grains of an average general bulk. Where they are large, the cross fracture of the rock is very

remarkable; all the grains being closely packed and separated by the least possible quantity of the mica, so as to give it an undulating appearance. In general, the quartz is transparent and crystalline; but in the coarser varieties, it is not unusual to find some of the grains consisting of a saccharine opake quartz; and in these cases the specimens might easily be mistaken for gneiss, as the latter present a resemblance to felspar which can only be discovered to be fallacious by the lens: the deception is particularly strong when, as is not unusual, they have a pink hue. As real grains of felspar do however occasionally occur, this variety must, in strictness, be ranked with gneiss.

The chlorite schist occurs under a much greater variety of aspects. It presents among others a set of varieties precisely similar to those just described; chlorite being substituted for mica.* It is also found in a more ordinary form; consisting of scaly chlorite interlaminated with quartz, which is more or less continuous, or else granular. In a simpler form, it consists of an intimate and fissile mixture of quartzose sand and chlorite; the former becoming occasionally so fine that it cannot be detected by the eye; when the specimens assume a dry earthy aspect. From this it passes gradually, either into the common continuously laminar, or scaly variety of chlorite schist; being either straight or undulated, and often possessing a high degree of lustre. At this extremity of the series it graduates into common clay slate; while, at the former, it is connected by a transition equally undefineable, with micaceous schist.

The clay slate presents, like the former substances, a considerable diversity of character. Where it is immediately united with the chlorite schist it is often greenish,

* Among many varieties which it would here be superfluous to describe, a remarkable one occurs containing green compact felspar intermixed with the other ingredients; which, rigidly considered, is also a gneiss.

or pale grey; and, not uncommonly, these colours are intermixed in the same specimen, with the more common dark blue or pale blue tint so prevalent in this rock. This variety is generally fissile, and either straight or minutely undulated: the beds in which it prevails are in many places wrought for economical purposes, throughout the whole extent of this series from Arran across the mainland. Occasionally, it refuses to split into parallel plates, the continuity of the laminæ being interrupted by the multiplicity of transverse joints; and it is often also capable of being separated into thick pieces without being subsequently divisible into thinner plates; the laminar continuity being in certain parts interrupted. The non-fissile substance common in the clay slates, and analogous to hone, or whet slate, also occurs in this series. The finer variety occasionally becomes nearly black and approaches to talcose schist, the laminæ being separated by that mineral; and, still more rarely, it is found to contain hornblende. In the progress of change, it also becomes intermixed with distinct scales of mica, and with quartz sand; thus passing into graywacké.

This latter substance presents a great number of varieties; graduating from the finest texture thus described, through various stages, into a rock so coarse as to deserve the title of a conglomerate. But the prevailing varieties consist of sand or gravel united by clay slate; and like the micaceous schists before described, grains of various sizes are rarely intermixed in the same fragment or mass. Where they are of very large size, the rock sometimes contains so little of the argillaceous cement as to present an almost entire congeries of gravel. Occasionally, mica, chlorite, or fragments of the several schists already described, are intermingled with these grains and fragments.

The limestone is generally in thin laminæ, interleaved with the clay slate, which it peculiarly accompanies. It is commonly of a fine texture with a smooth even frac-

ture, but occasionally also, crystalline and large grained; the colours being either smoke grey or white.

With respect to the general order of these several rocks in the series, it is the following. The micaceous and chlorite schists prevail near the series of micaceous schist which precedes the argillaceous series; but are not exclusively limited to that part, since the latter in particular, are intermixed with the clay slate, and extend, even beyond it, to the borders of the secondary strata. The former is also frequently found in the same situation; so that the clay slate, which in a general sense may be said to occupy the middle of the belt, is sometimes included within the micaceous schist. In some parts of the line already so often alluded to, the graywacké schists prevail near the borders of the series, so as to come into contact with the secondary strata; and this appearance takes place to a considerable degree in Bute. But in many others, no such distinction is to be observed; the fine clay slate being found alternating throughout with the coarser or graywacké schists, even to the very borders of the sandstone. That mixture is often so intimate that both substances exist even in the same specimen; not even an alternation of the several beds occurring, but the same lamina frequently presenting both structures. In other cases, beds of the clay slate occur among those of the graywacké, being extenuated at their sides into thin edges; and, in a similar manner, the latter rock is found imbedded in the strata of the former. In terminating these remarks on the nature of this series, it is not unimportant to point out the strong resemblance in structure between the graywacké and the coarse varieties of micaceous and of chlorite schist. In all, it is precisely the same; the difference consisting only in the nature of the cement.

The different rocks that have thus been enumerated as belonging to this series, do not all occur throughout the whole line where it is found; nor are the inter-

mixtures always equally frequent and irregular. That portion of the belt however which reaches from Arran to Loch Lomond, exhibits the whole of them, as they have now been described, in almost every part; and they will also be found to occur in many places to the eastward of this limit. Towards Dunkeld the series is more simple, presenting little else but the argillaceous and graywacké schists; although the recurrence of these two members is here as irregular as where the series is more complicated. It may also be remarked, that in this case the boundary towards the micaceous schist is more definite than where the series is most perfect; it being impossible in the latter places to point out any limit where the one commences or the other terminates.

This general account of the argillaceous series, as it was required to illustrate the structure both of Arran and of Bute, will also suffice for the description of that portion of the latter island where it occurs. It is only requisite to add that it is here displayed in great perfection, containing every one of the substances that have been enumerated. The boundary will be better understood by inspecting the map than by a verbal description; and it is sufficient to remark in addition, that although definite near the sandstone, it is undefinable near the micaceous schist, as it is every where on the adjoining mainland.

At a certain distance from this indefinite boundary, the series of micaceous schist in this island becomes exclusive; appearing with the same characters which it possesses throughout the adjoining district of Argyllshire and in many other parts of the mainland where it approximates to the argillaceous series. It is so frequently of a greenish colour as to render it doubtful whether it should not be ranked with chlorite schist; into which it here occasionally passes, as in the neighbouring districts. The limits of those two rocks are indeed so evanescent that it appears impossible to sepa-

rate them effectually; and it is often rather from the predominant characters of the whole series, than from the aspect of any particular portion, that a single term for designating them must be derived. These schists, as they occur in Bute, whether ranked under the one or the other title, present considerable diversity of structure; but the most marked are those in which the quartz is intermixed with the mica or chlorite in a granularly laminar, or in a more continuously foliated manner.

I may add to this account, that slate quarries are wrought in different parts of the island; no distinction being made among the various substances, but every one being attempted which promises to admit of the requisite mechanical conditions. The principal quarries are about Scalspie and Bannatyne.

Before terminating this account of the primary rocks of Bute, one remark of a general nature may be made on the nature of the argillaceous series, involving geological doubts of considerable importance. It must have already appeared in many parts of this work, that no necessary geological distinction exists between graywacké schist and common clay slate; while it has also been proved that these rocks occur in alternation with all the other primary strata. Even here, it is seen, that although the clay slate occupies a position near the outer margin of these strata, it is not followed by the graywacké; but that both substances, even where the series is most simple, are intermixed, so as to form different parts of one general deposit. In this case therefore, as in many others, there is no geological distinction between the two, which appear, on the contrary, to be different parts of one mass, composed fundamentally of blue indurated clay and quartz, and differing only in the relative minuteness and proportions of these different ingredients. It will be a question for geologists to consider, whether the appropriation of the term graywacké to a particular variety of argillaceous schist, does not

form too strong a distinction; and whether it has a claim to be considered as conferring an exclusive geological character on any series existing in nature. The analogy between the conglomerated or coarser varieties of the micaceous and chlorite schists occurring in the series of Bute, and the graywacké of the argillaceous schists, is striking; and these may, like that substance, be considered the graywackés of those rocks. It would be superfluous, if not injurious, to make such a distinction in those cases; as the transition from the most mechanical structure to that which possesses the least of this character, is indefinite; and the same rule appears advantageously applicable to the latter. In such a case, the geological distinction would be that of argillaceous schist simply; comprising every variety of structure in which clay slate and quartz were the fundamental ingredients; the term graywacké being reserved as a mineralogical designation only, or as the name of a species of rock. If a rock of this structure be indeed found in nature, distinct from fine argillaceous schist, and possessed of other geological characters so striking as to confer on it a claim to a distinct place in the history of the earth, it will be worthy of consideration whether some geological term ought not to be adopted for distinguishing it from those which are found in the various situations I have formerly described, alternating with common clay slate and with the other primary strata. The term of *transition* is too hypothetical; and such a distinction, if it really exists, much too difficult of application, to render it of use in this case; while it must inevitably lead to the practice of concluding, rather than to that of investigating.

It will perhaps be thought, that in stating the preceding facts, and in deducing the remarks to which they have given rise, confusion has been introduced where the labours of others had established regularity. The facts themselves may even be considered as ex-

ceptions; but when these become numerous, rules are rendered useless. A certain regularity is doubtless characteristic of all the operations of nature; but the pursuit of regularity is seducing, and the conclusions with regard to it, are too often premature. A scrupulous regard to truth is more peculiarly necessary in the infancy of a science; and in substituting an imaginary for a real order, its progress is more frequently retarded than accelerated.

The general extent of the sandstone has already been pointed out in the sketch of the island, and a few minute particulars will complete the account of its topography. On the west side, it passes the flat isthmus, and is seen for a short space along the shore of the Garroch head, where it is distinctly visible under the trap. A small and detached portion, accompanied by limestone, is also to be found at low water on the shore near Scalspie point; which, although separated from the general mass by the intervening schist, occupies its proper place in the linear direction of the junction of these two classes of rock. On the east side of the island it occurs also, under the trap; extending about half a mile from Kilchattan bay along the shore, and reaching to a thickness of three or four hundred feet in the hill. These beds dip to the south-west, in an angle varying from ten to fifteen degrees. The dip here named, is however not universal; and in this respect Bute partakes of that irregularity which characterizes the red sandstone throughout the whole of the Clyde islands. The conglomerate between Rothsay and Ascog, dips to the south-east at twenty degrees or more; near the Garroch head again it is almost horizontal.

With respect to the composition of these strata, it may be remarked that the general characters are identical with those of the lowest beds in Arran, and that the finer varieties and the conglomerates occur indiscri-

minately, and in a disorderly manner. They present but few of the occasional substances or more limited beds which occur so abundantly in that island; yet different varieties of coloured shales passing into iron stones, are to be observed in some places.

On the shore between Ascog and Rothsay, fragments of an irregular bed of limestone are found in the conglomerate. This is of a mottled grey colour, and at its boundaries graduates into the contiguous rock; involving fragments of the several substances that are imbedded in this stratum. Similar appearances are very common in Arran. I may conclude the subject of the red sandstone by remarking, that where it gives passage to trap veins it often assumes the same colour as the vein; a phenomenon also of frequent occurrence in that island.

The other appearances of limestone in Bute are scanty. A small portion of a bed is visible between Scalspie and Kilmory; imagined by the natives to be a portion of that which appears above Kilchattan bay, and which is the only conspicuous mass in the island. This latter bed seems to lie above all the sandstone strata at this place, and to be the rock immediately in contact with the superincumbent trap. It is traversed by trap veins, which appear to have their origin in the great body of that substance; and from this cause probably, the disposition of its beds is disturbed, although the general bearing of the whole is sufficiently regular. It does not contain any organic remains that I could discover; although they may still exist, since they are found in some of the limestones of Arran that are similarly situated. The colour is a pale blueish grey and the fracture earthy, where it is most simple and has undergone the least apparent disturbance. In most places however, the shales, with which this limestone is in other cases regularly interstratified, are twisted about and irregularly mingled throughout the whole mass;

that change occurring in the immediate vicinity of the trap, the influence of which it bespeaks. Here it acquires a mottled colour, presenting purple and red stains from the intermingled shales; which all present the same appearance of high oxydation in their constituent iron; while at the same time it acquires an aspect so argillaceous that it can scarcely be recognised as a limestone. It is unfit for building, but the purest parts are selected for agricultural purposes.

The last of the rocks is the trap. This has been shown, in the general sketch, to constitute nearly the whole of the Garroch head, but there is also another much inferior portion which will afterwards be described.

The general disposition of the trap at the Garroch head has already been mentioned; and, in examining into the causes of these ridges and prolonged vallies, it will be found that the whole promontory consists of a series of beds of which the direction is north-westerly; while they dip to the south-west in an angle of about fifteen degrees. They present a perfect appearance of parallel stratification; their abrupt edges declining from the perpendicular in an angle equal to that of their dip, and often forming high inland cliffs of greater or less extent, prolonged on the line of their bearing. It will be seen, on reverting to the position of the sandstone, that these beds lie over that rock in a conformable manner; and they possess an almost absolute parallelism throughout. The overlying position is distinctly seen on the west side of the island, less perfectly on the east. Among the numerous instances of apparent stratification in trap which have occurred in the course of this survey, the present is infinitely the most regular and perfect; since, as far as I could perceive, it does not in any instance betray indications of a disposition different from that of the sandstone on which it lies. Yet, as its contact with this rock is but imperfectly visible, it must not be concluded that such irregularities

do not exist; and there is little doubt that a sufficiently extensive examination, were that attainable, would detect circumstances similar to those which, in a corresponding case, have been pointed out in Sky, and of which abundant examples are not wanting every where. There are, indeed, some circumstances here actually present, although but imperfectly marked, that tend to associate this regular set of trap beds with those which have been shown decidedly to interfere with the subjacent rocks. These are the veins which traverse the sandstone in many places, and appear to spring from the principal mass; but no opportunity is afforded of tracing them in a very unquestionable manner.

The trap of the Garroch head sometimes presents a rudely columnar aspect on its abrupt faces: more generally it is amorphous. It varies in composition, but is in almost all cases so deeply weathered that it is extremely difficult to procure fresh specimens by the hammer only. Greenstone is occasionally found in it, and this has now and then the porphyritic structure. But the predominant substance is that lead-blue compact and uniform rock of an earthy aspect, already noticed in Pladda, which has often been called greenstone, and by a few, from the compactness and uniformity of its texture, basalt. It is intermediate in hardness between claystone and clinkstone; the alterations of colour on weathering, appearing in some cases to depend on changes in the iron of its composition, while in others the clay becoming disintegrated, assumes the whitish pulverulent appearance that characterizes all the rocks of this species as it does the compact felspars. This substance, like the greenstone, is also occasionally porphyritic; the imbedded felspar being glassy, but the crystals always sparingly dispersed.

The next, and only other mass of trap, occurs at Ascog: although of comparatively insignificant extent, it requires particular detail; partly on its own account

and partly as it is the repository of a bed of coal. I did not trace it inland beyond half a mile; the covering of soil impeding this investigation; but this defect is of no moment. There is no ready mode of estimating the thickness of this mass, but it may be taken at 100 feet or more. When examined on the shore, it appears rather to pass through the sandstone than to lie over it; but there is considerable obscurity in this place, as the lateral junction of the two is concealed by a cavity filled with earth. If examined in the interior, it is seen decidedly lying above that rock, in the stream that turns Ascog mill; but these two characters are not incompatible. It may even be imagined that it has once formed a bed or mass intermediate to the sandstone; since the prolongation of the neighbouring strata, which bear marks of waste, would cover it; but these conjectures are of little value. In composition, it resembles the rock of the Garroch head; frequently however presenting, when fresh broken, a greenish colour with the waxy aspect of serpentine: but it loses both this colour and appearance on drying, since, like many other rocks, even of this family, it contains water when in its native place, which soon quits the detached specimen. It presents in some places the apparent characters of a greenstone; but, on a rigid examination, it is evident, that the dark material is a dark green compact felspar, and the light, as might be expected, a white one. This variety, as I have elsewhere remarked, has been confounded with true greenstone; the colours and the speckled aspect being taken as the criterion. It may not always be very easy to distinguish these two substances, yet it is necessary to be accurate in the description of rocks; although, as in the present case, we should be compelled to resort to a circumlocution in the want of a specific term. Occasionally this rock becomes a regular porphyry.

This mass contains in one place a vein, presenting an appearance, which however common it may be in mineral veins, is not so in this rock. This vein is a complicated calcareous one, the greater part of it consisting of a breccia formed of fragments of the trap cemented by the calcareous matter. It is probably the effect of subsidence and fracture, by which detached pieces have fallen into a cavity and been subsequently enveloped by infiltration.

The principal mass thus described, is superincumbent, near the shore, on a softer and clayey substance; which is also stratified and parallel to it, with a common inclination. This is succeeded by a bed of coal, which will be described hereafter, and that by a second bed of the same clayey rock, below which there is no further access to any alternations that may exist. This rock is of a pale lead grey, and of a hardness intermediate between that of the earthy amygdaloids and dry clay. It decomposes by a kind of exfoliation, into balls and irregular masses; and is often porphyritic, the felspar being as tender as the base; as if the whole had undergone together some change from the original hardness of a trap porphyry. No similar substance has occurred among the numerous trap rocks examined in the course of this survey. The dip of these beds is westerly at fifteen degrees, and they are not visible in the other parts of the hill; nor indeed would they have been exposed here but for the workings made in the coal.

There is a trap vein near the mass now described, lying in a north and south direction, and nearly vertical. It is probably a branch from that; but this cannot be proved, since the shape of the land, and the nature of the shore, prevent the connexion from being traced. It may indeed be a vein of a later date than the overlying trap, this occurrence being common; in which case there would be two distinct formations of trap in Bute, as in Sky and other places; but I could not trace any instance of a vein actually traversing the trap of the Garroch head; which, being a sufficiently extensive mass, might be expected to

contain them if they existed as distinct veins. Future geologists may try to ascertain this fact, although it cannot be considered of much importance.

Similar veins are very abundant. They are seen in several places traversing the sandstone between Kilchattan bay and Rothsay, and a very conspicuous one occurs at Scalspie point. They vary much in size, being sometimes very minute, and occasionally attaining, as in other places, a considerable dimension. They are at times erect, at others inclined, and more rarely they are curved in their courses. In one or two places they may be observed to ramify; a feature by no means common in them, although extremely remarkable in Airdnamurchan.* As far as I have observed, they consist of the same substances as the overlying masses described above. In some places they are also to be seen traversing the schistose rocks, appearing to have very extensive courses; but they are, from the want of contrast, less obvious in these rocks than in the sandstone; and on this account perhaps, appear less numerous. It is not uncommon to find the larger veins with a laminated structure, which is further cross fractured into imperfectly columnar divisions. It would serve no useful purpose to enter into the details of these several veins; but I shall conclude this account of them by a particular description of two, which seem to claim it from the peculiarities of structure which they exhibit.

It has on former occasions been seen, that several varieties of trap, tufaceous, columnar, simple, and amygda-

* As the ramification of trap veins is a very important feature in their history, and no very distinct example of it has occurred in this survey of the Western islands, I have subjoined a sketch of part of the shore of that promontory, where this phenomenon occurs throughout a large space. The stratified rock is the limestone common to Mull and Morven. The specimen selected is one of the most simple, as the intermixture, multiplicity, and minuteness of the veins, are such as generally to defy the powers of the pencil; particularly as no point of view can be obtained but from a boat, in a sea which is never at rest. Plate XXXIII. fig. 1.

loidal, occur in the same vein; but in all the cases described, these different substances were disposed in a laminar direction, or parallel to the sides of the vein. But, above Kilchattan bay, an instance occurs, where several varieties are to be seen, disposed, although in a somewhat irregular manner, across the vein, which is here about six feet wide. The substances thus found are, greenstone porphyry, containing very large crystals of glassy felspar, a tufaceous rock, a very fine basalt decomposing into balls, and common greenstone.

The large vein, before mentioned as appearing to proceed from the mass of trap at Ascog, presents a singular and, at first sight, a very deceptive appearance.* It is laminar, or divided into layers parallel to its sides, and is at the same time vertical. At the inner edge, or west side, (its course being north) it appears to contain fragments of limestone occupying one of the laminæ, accompanied by some larger parallel portions of the same substance. A close examination discovers the true nature of this appearance without diminishing its singularity. It is thus found that the outer laminæ, which appear, like the inner, to be parts of the vein, are not trap, but shale; and that the limestone fragments are contained in this substance, not in the trap. This shale is so fine and compact that it can scarcely be distinguished from a basalt; but pursuing it further outwards from that part of the rock which, from its greater hardness and permanence, seems to appertain to the vein, it is found to be succeeded by a coarser shale alternating with sandstone, still vertical, or parallel to the real laminæ of the vein. These differ in no respect from the ordinary shale and sandstone that form the shore; but which, every where else, are in their usual horizontal position. Not far off, the same shale, containing fragments of limestone, are found together with the simple shale and the sandstone, in that which may be

* Plate XXI. fig. 3.

called their natural position, and in the same order which they occupy relatively on the edges of the vein; the first of these rocks being the lowermost. Unfortunately, the rolled stones which cover the beach to a great depth, prevent the possibility of tracing the connexion between these strata in their vertical and in their horizontal position. The sketch which accompanies this description, is intended to represent the mode in which this appearance seems to have been produced; representing the actual state of the rocks and the proposed explanation. It is possible that there may be a fracture where I have only supposed a curvature; but it makes no material alteration in the views of this very interesting phenomenon. The calcareous breccia will appear, by this drawing, to be situated below the sandstone, and can therefore rarely be seen in its natural position; becoming here visible only in consequence of its edge being thus turned upwards.

Among the numerous instances of displacement produced by the passage of trap veins, no case exactly similar to this, or of so marked a character, has occurred in the innumerable examples of such veins that I have examined; although marks of a force acting upwards are not uncommon. The very partial and limited, as well as decided marks of such violence here, render this case particularly striking; and points our attention strongly to the probable cause, namely, the protrusion of the vein from below.

I shall conclude this account of the rocks of Bute with a brief description of the bed of coal mentioned above. Having been wrought at different times, it is easily examined. The working has been carried on by driving from the face of the cliff on the course of the stratum; and having been, as might be expected, found unprofitable, it has been finally abandoned: much against the wishes and inclinations of the natives, who, as usual in cases where coal is concerned, can with difficulty be convinced of the futility of this pursuit; even under circumstances far more

hopeless: so strong are their wishes and so great their jealousies on this point.

The bed lies between the two strata above described, with a common dip to the westward and an inclination of ten or fifteen degrees; but that cannot now be accurately ascertained, the workings being full of water. It varies from two to three feet in thickness, and is of a dry quality, containing at the same time much pyrites. A sort of ferruginous indurated clay, resembling a decomposed pyritical shale, is interposed between it and the soft trap rock. It is said to have been formerly wrought in other places along this shore; but there are not now any traces of other workings to be seen. Attempts have also been made to cut it in other parts of the hill; but they have been abandoned almost at the outset. It is sufficiently obvious that they should not have been made; as such a bed of coal so situated, could hold out no prospects of remuneration.

It also appears that coal has been found on the west side of the island near Scalspie, and that it was situated in the sandstone. This is sufficiently probable, as the same mineral occurs in that situation in Arran; but there is no longer any access to examine the spot, as the pit was filled up after an unsuccessful pursuit.

As the small island of Inchmarnoch, which lies on the west side of Bute, presents no circumstances which can entitle it to a separate consideration, it will be sufficient here to say, that it resembles in every respect that schistose district of the latter with which it corresponds in the linear direction of the strata; being also, like that, noted for its slate quarries.

Of the minerals which occur in Bute, chlorite is by far the most abundant and conspicuous. It is frequently found in the usual scaly form, filling the minuter rifts of the clay slate; nor is it necessarily confined to those varieties which pass into chlorite schist, being equally common in the dark blue rock and in the whitish speci-

mens. Occasionally, it is crystallized at liberty within the cavity; the hexagonal plates being accumulated into hemispherical bodies so as to present the appearance known to mineralogists by the name of coxcomb, and common in sulphat of barytes. In other cases it seems to be peculiarly associated with the veins and nodules of quartz that are found in the schists. When that happens, it is sometimes disposed in laminæ among the quartz, at others in irregular nodules. In this situation it is also sometimes crystallized, and either totally or partially imbedded in the quartz. These crystals consist of a prolonged hexagonal prism, generally incurvated in various directions, and often much contorted into vermicular forms. The edge of each scale is visible on the surface of the prism, so that the whole presents a transversely striated aspect. Such crystals are well known to collectors as being sometimes entirely imbedded in transparent quartz; in which case they are much valued. Where the quartz and chlorite are thus associated, the former is frequently found of an intense dark green colour, but still possessing its natural lustre; and, although opake in the mass, translucent on the edges. Although the colour is in this case evidently the result of the chlorite, since the scales of this substance are often found distinctly visible and producing a more dilute tint of green, it is impossible, in the darkest specimens, to distinguish it from the quartz, the mineral presenting a uniform and simple texture. As happens in the case of prase, which bears the same relation to actinolite, the colouring matter appears as if it existed in the quartz independently of the substance to which it might be supposed attached. This green quartz is sometimes crystallized, but the forms, as far as I observed any, are incomplete; although such faces as actually occur, possess the same incidence on each other as those of a simple quartz crystal; affording a proof, like the spar of Fontainebleau and other analogous cases, that the form of a crystal is not necessarily affected by the mixture of another substance. The mineral thus described

is abundant on the mainland adjoining, where the same series of rocks occurs; and has inadvertently been taken for prase.

Calcareous spar, of a pink colour and nearly transparent, is sometimes found in the argillaceous schists; but generally occupying the cavities completely, or so nearly filling them as to present no decided geometric forms.

Brown spar is more common; displaying the ordinary curved rhomboidal figure, and frequently covered with the golden metallic lustre sometimes occurring in this mineral. Another variety is also found, but much more rarely, of a dark red brown colour and very deceptive appearance; resembling, on a superficial view, the dark red varieties of common felspar. This substance also occurs in some places, in the form of veins, occupying a small space, and often associated with the brown spar and the chlorite.

In the clay slate, micaceous iron ore is occasionally found; presenting specimens of great brilliancy, and generally intermixed in veins or rifts with quartz and calcareous spar. The laminæ are sometimes thin and prolonged in the shape of ribands, being entangled together or crossing throughout the rock in an irregular manner. Oxidulous iron in the form of octoedral crystals, abounds in the chlorite, or micaceous schist at the northern extremity of the island. These vary from the tenth to the sixth of an inch in length; and, suffering no change from exposure to air, are seen glittering in the sun over the weathered surfaces of the rock; while they may also be collected in abundance from the gravel formed by its decomposition.

CUMBRAY (GREAT).*

In the preceding description, it has been shown that Bute consists of two distinct portions, the northern being formed of the primary schistose rocks, and the southern of secondary strata associated with trap. By the former it is connected geologically with the Argyllshire coast, to which it approximates so nearly in position; by the latter its affinity to the more distant land of Ayrshire is equally established; the same rocks occupying the whole of that district where it bounds the æstuary of the Clyde.

The intermediate position of the two Cumbrays, no less than the correspondence of their structure, both with Bute and with the adjoining mainland, serves to draw still nearer this affinity, while it further assists in throwing a general light on the geological connexions of all the islands comprised in the present group, with each other and with the surrounding shores. Independently of this, the Cumbrays present some interest in themselves; an interest which would have been more considerable, had not the occurrence of similar facts on so many preceding occasions, abated the edge of curiosity on these subjects, and superseded the necessity of a minute description.

The great Cumbray is three miles in length and one and a half in breadth; consisting of an irregular undulating tract, the altitude of which does not any where appear to exceed 500 feet. The surface is almost every where high, and it therefore presents throughout the greater part a bleak and barren aspect; the cultivation being limited to a small space and the larger portion appropriated to pasturage. In general, the land descends towards the shore by grassy declivities, occasionally interspersed with low rocky faces displaying the edges of the strata; but at the south-

* See the Map of Bute and the general Map.

eastern angle, a mass of cliff occurs, giving free access for a considerable depth to the rocks that form the body of the island.

On the southern side lies the small and neat village of Millport, possessing a numerous population, partly employed in the fisheries, and partly occupied in the manufactures of Glasgow. Some detached rocks here form a secure harbour for fishing boats; its capacity being so limited as to be incapable of containing more than two or three vessels. The situation of this village is pleasing, but the want of wood in the island detracts much from the picturesque effect which might, under any system of planting, render the great Cumbray one of the most beautiful spots in the Clyde. There is no natural disadvantage to prevent the growth of trees, as is proved by the example of Bute, and by that of the neighbouring coast of Ayrshire; both of which, under similar exposures, are interspersed with considerable tracts of woody land. The chief beauty of the great Cumbray arises from the magnificence and variety of the surrounding scenery; the distance presenting the rugged outlines of Argyllshire and the spiry mountains of Arran; while the adjoining coast is highly cultivated, and covered with villas surrounded by ornamental wood. The town of Largs and the castle of Fairley, spots celebrated in Scottish history and in Scottish song, add materially to the interest of the scene; which is further enlivened by the incessant passage of vessels navigating the Clyde, and by the rapid motions of the steam boats, each, like a floating volcano, drawing along its expanding stream of black smoke.

The great Cumbray corresponds exactly in geological structure with the middle region of Bute. It consists of a mass of red sandstone traversed by trap veins, and in this respect partakes also of the character of the neighbouring shore; forming an appendage to the great mass of sandstone and trap which occupies so large a part of this division of Ayrshire. As is usual in the neigh-

bourhood, it contains beds of the conglomerate generally attached to the sandstone. The finer varieties however predominate; nor do the beds present those various substances which occur among them in Arran, and, although more sparingly, in Bute. Almost the only exceptions are found on the shore at Millport, and in two small islands which form the little harbour at that place. These consist of beds of white and of grey sandstone; the former being predominant, and resembling those which are found in Arran at Corry. The latter are in small quantity, and appear to derive their colour from a portion of blueish clay entering into their composition. There is also a small quantity of limestone to be seen in the island, which has been wrought for agricultural purposes. Appearances of coal have also been observed, and some attempts were made to ascertain its extent by digging. But these were not attended with success, nor does there appear any temptation in an economical view to pursue these indications. As a geological fact it is no longer interesting after the description of Arran, since it evidently belongs to the same variety occurring there at the salt pans.

The sandstone of the great Cumbray dips, in a general way, towards the north, in an angle, at a medium, of about ten degrees. This remark is not to be taken strictly, since, as in most other situations where they occupy low angles, the strata, from their undulating disposition, present different elevations, and even in some cases become horizontal.

It might have been expected from the structure of the adjoining coast, as well as from that of the little Cumbray and of Bute, that overlying trap would have been found in this island also. It does indeed occur, but in very small quantity; being limited to a minute patch existing on the western shore, where it is indicated in the map and in the general section of these islands.*

* Plate XXXIII. fig. 3.

This is probably the remains of a more extensive portion which has in the lapse of time disappeared; a conjecture which is strengthened by the remarks that will immediately be made on the obvious waste of the sandstone.

Trap veins are however very abundant, while they are also highly conspicuous, traversing the sandstone in various places, but appearing to be most numerous in the neighbourhood of the ferry. They cross the island in a somewhat north-easterly course, being at times curved, but generally straight. One instance occurs where the vein is bent at right angles, being at the same time of considerable dimensions; a circumstance very unusual. These veins are of various breadths, ranging from six feet to as many yards. They are commonly erect, and often stand high above the surface like walls; a phenomenon not very uncommon in many of the Western islands. One of them is particularly remarkable for the length through which its course is visible, as well as for its continuous projection along the whole line.

I have mentioned some remarkable instances of the same fact in Isla and in Jura, where the remains put on the appearance of castles, standing insulated on the sea shore. One very striking example occurs in the former island; where a vein of this kind is seen traversing an extensive tract of the high land for many miles; holding an uninterrupted straight course over hill and valley, and resembling, from its length and regularity, those march-dykes which the new division of farms has recently introduced into many of the pastoral districts of Scotland. In Mull, as it was also remarked, and more particularly on the shores of Loch na keal, they are exceedingly conspicuous, from their great regularity, as well as from the height to which they rise above the surrounding soil; while the partial concealment afforded by the growth of shrubs and the investing ivy, give them in a still greater degree the appearance of works of art. On the eastern shore of the same island, there is to be seen one of the most

remarkable which occurs through the whole range of these coasts; always pointed out by the mariners to strangers who navigate the Sound. It occurs between Aros and Tobermory, standing far out from the cliffs on the flat shore which here skirts the margin of the sea. One, at least equally remarkable, occurs in a similar situation near the point of Sleat in Sky, attaining to the height of forty feet: those which I have pointed out near Loch Craignish, and those more recently mentioned in Arran, must be still fresh in the reader's recollection. It is indeed unnecessary to protract this enumeration, as examples of the same fact must have been witnessed by all those who have traversed the western parts of Scotland. In enumerating those above mentioned, my object is to distinguish the two opposite situations in which such outstanding veins are found; namely, on the shores of the sea, and on the elevated land far out of its reach; and this for the purpose of founding on them some remarks of a general nature.

It requires no arguments to show that these veins have derived their forms from those of the fissures of the surrounding rocks; and that however far they may now project from the present surface, they have at one time been surrounded by the strata, to the removal of which they owe their present appearance. They offer therefore a gage, or criterion, by which to judge of the waste of the surrounding land, at least to a certain depth; since it is in many cases obvious, from the ruins which surround them, that they are but imperfect records; having themselves participated in the general destruction of the surface. Hence also we may fairly conclude, that the surface of the land is, in many other instances, in a state of waste; although we may have no criterion like this by which it can now be indicated.

With respect to those that are found on sea shores, as in Isla, Mull, Sky, or Arran, the destroying causes are so obvious that it is superfluous to point them out. Nevertheless it is not uninteresting to contemplate the

great waste which, in many of these cases, the land has undergone from the action of the sea. Passing over that which might be deduced from these appearances in the sound of Isla, and which bespeak a once nearer approximation of the opposite shores, it is sufficient to contemplate the southern coast of Arran only. Here, a considerable range of long outstanding dykes is now to be seen, forming natural piers in the sea. It is scarcely to be questioned that these were once surrounded, or their intervals filled, by solid land; but to what height, cannot now be conjectured, as the veins themselves bear marks of ruin and degradation. The same remarks are applicable to many other parts of this island, as well as to Pabba and other shores where similar prolonged dykes occur; but I need not point out more of these, satisfied with having indicated the most perfect record which geology affords of the wasting action of the sea upon the land.

The other case, that of the outstanding inland dykes, such as those of Cumbray, and the more conspicuous examples in Isla and Mull, is more difficult of explanation. It is equally evident however, even in these instances, that the surrounding strata must once have existed at least at the same level as the summits of the present dykes; nor can any obvious causes now be traced by the operation of which so great a removal of land has been effected. There are no rivers in any of the instances enumerated, to which it could be attributed; nor indeed could any action of a river be imagined, capable of producing those effects on surfaces so irregular. They have probably resulted from the tedious operation of the atmosphere: the rains and the frost first loosening the surface of the rocks, and the slow drainage of the surface waters causing the subsequent descent of the pulverized materials to the lower grounds; where they accumulate to form the ordinary soil that covers the substratum. In this way, probably, many of those accumulations which have often been attributed to diluvian causes, are formed;

although there is no doubt that these have in many cases produced the appearances here noticed. An instance of alluvia thus generated by the gradual descent of the surface along the declivities of the mountains, was already pointed out in Arran, and they are of common occurrence throughout the Highlands, as they doubtless are elsewhere in similar situations. They form an important modification of a class of phenomena which has not yet been studied with the attention it deserves.

The veins of the great Cumbray present many different varieties of composition; but greenstone, basalt, and porphyritic traps, are among the most common. Two only, appear sufficiently remarkable to claim a more distinct notice, after the innumerable observations on similar substances which have been scattered throughout the foregoing pages. One of these is conspicuous for its foliated structure; examples of which have however been pointed out before. The other is traversed by numerous reticulating veins of calcareous spar; a circumstance which I have not elsewhere observed in the veins of trap, though not very uncommon in the great overlying masses. It is said that gypsum has been found in Cumbray, but it did not occur in my researches, nor could I obtain any authentic information on the subject.

With this brief but sufficient sketch, the account of the great Cumbray is terminated; but as this is the last occasion on which the sandstone of the Clyde will come under review, it will not be useless now to remark, that our knowledge of the several deposits of red sandstone occurring in Britain appears as yet imperfect. It may be a question indeed whether that imperfection is not, to a certain extent, rather imaginary than real, and produced by the adoption of certain general characters to which those of the several deposits do not in all points conform. On investigating the causes of this uncertainty, it appears to have resulted in some measure from the unavoidable use of the term red, thus often leading observers,

from the inevitable consequences of association, to separate substances in other respects allied, to confound together rocks differing in other more important particulars, and to unite formations essentially distinct, by one unessential and varying character. It is equally evident that the relative position of any given series to the primary rocks, does not in itself constitute an unvarying and essential character; as the partial nature of the secondary strata frequently causes the upper members of an extensive deposit, or even those of different deposits, to rest on these; an example of which has already been pointed out in Morven. The term of old red sandstone, thus derived from position chiefly, appears in this way to have been also an occasional source of obscurity and confusion.

It must already have been perceived that, in consequence of these views, the primary strata of the Sandstone islands have been confounded with that series which skirts the southern border of the Highlands, to which this island, like the rest of these strata in the Clyde, appertains. It will be a subject for the inquiry of others, whether this series does not differ from the red sandstone of England also, as well as from analogous deposits existing in other parts of the world. I need not recur to the peculiarities by which it is characterized in Arran; but it is evident that the white sandstone, together with the shale, limestone, and coal, are all portions of it; and characters similar, if not equally perfect, will be found to pervade the whole tract. All these substances here alternate with that red sandstone which they have been usually supposed to follow as a distinct series, nor is there any difference between the upper and lower members of that deposit; a supposition which has been adopted for the solution of this imaginary difficulty. If, in this particular instance, the red colour be supposed unessential, a great part of the difficulty vanishes; although the coal and limestone of the Arran series, will still appear sufficient to

distinguish this deposit from the red sandstone of the English strata, as innumerable other circumstances do from the red marle of the same country. The revolutions of the surface have been produced by general laws; but those of the parts must have been subject to particular modifications of those actions, by which the results now visible have been determined.

With respect to distinctions drawn from relative position to the primary rocks, there is no more cause for surprise that the red sandstone of one district presents important differences from that of another, although equally incumbent on the primary strata, than that the complicated series of the argillaceous schist of Bute and the connected tracts, differs from that in which the same rock occurs in Wales. The rule of conduct for a geologist in this case, appears simple. If instead of being satisfied with general terms, derived from examples of which the analogy, if apparently obvious, is not ascertained, possibly not correct; if instead of prematurely classing together in artificial arrangements, appearances which have not been investigated according to all their natural affinities and characters, the observer shall study and record facts, the science of geology at large, not less than the red sandstone, will hereafter give ample indications of his industry.

CUMBRAY (LITTLE).

This island is separated from the former by a strait more than half a mile in breadth, and from the coast of Ayrshire by a continuation of the channel which equally divides both these islands from that shore. It is of an irregularly triangular shape, being about two miles in length and scarcely more than one in breadth. Judging by a rude estimate, its highest point is between seven and eight hundred feet above the level of the sea. That summit is distinguished by the tower of the ancient lighthouse, now for some time superseded by the more modern structure; which occupies an inferior situation, less subject to be obscured by the occasional low flight of the clouds. On a small peninsula on the eastern shore, is seen a square tower in a state of good preservation; once a royal castle, like that of Pencross on the opposite coast. Both these buildings are of small capacity, exhibiting the general arrangement already mentioned as characteristic of the Highland castellated mansions. That of Pencross is of somewhat greater dimensions than the other, and is said to have been the station whence the royal funerals proceeded for interment to the place of sepulture in Iona. Unfortunately, so much doubt hangs over all the details of the early periods of Scottish history, that this tradition must be received with hesitation. Nor is it easy to understand what purposes of royalty these castles could have served, as they neither possess the extent requisite for a royal household, even limited as it may be supposed to have been in those days, nor could they have accommodated a garrison for any system of defence, or for the reception of an outpost. It is more probable that, like others, they were the strong houses of the feudal chieftains or nobles of those days. Rude however as they are in form, and insignificant in dimen-

sion, they conduce much to the picturesque appearance of this coast.

Some conspicuous remains of barrows are to be seen on the north side of the island, some of which have been opened and found to contain the usual objects discovered in similar situations elsewhere. Whether Danish or not, is a question of no great importance, could it be resolved; yet it is a matter beyond doubt that the Norwegians had possessions in the Clyde; their last stand having been made, and their final defeat having taken place on the mainland opposite.

The whole island presents a ridgy and terraced surface covered with verdure, the ridges being the faces of the beds of trap which are piled in succession from the base to the summit. The greater number of these abrupt faces looks to the south-west; in which respect they differ from those of the Garroch head in Bute, which are placed in the opposite direction; but it is to be supposed, that in both cases, the inclination of the trap beds is determined by that of the red sandstone on which they both alike repose.

As the great Cumbray was found to correspond in structure with the middle region of Bute, so the smaller resembles the southern point of that island; while it also corresponds with the neighbouring point of Pencross; the trap there reaching the shore in one precipitous face, though, elsewhere along this coast, it is confined to a certain range within the land.

The little Cumbray, nevertheless, gives indications of its foundation, in a very minute portion of the sandstone strata, which constitutes the small and low peninsula on which the castle is erected. This is the only place where that rock is visible, the trap every where else reaching to the sea; yet it is sufficient to prove the continuous structure of the whole coast, and to indicate that the trap, here as on the adjoining shore, reposes on the sand-

stone.* Fragments of white sandstone are also found scattered on the eastern shore; derived probably from some masses entangled in the overlying rocks, which do not appear, or at least escaped my observation.

The external general aspect of the trap rocks is various. They often present a rude prismatic fracture, and occasionally approach to a more perfect columnar structure.

The predominant varieties bear a strong resemblance to those of Mull; consisting of clinkstone passing to claystone, and displaying various intermediate stages of transition. They differ materially in aspect from the rocks of the Garroch head, but correspond with those of Pencross, and with an extensive range that forms the high land of the adjoining coast.

The colours are pale grey, dark grey, purplish brown, and reddish brown; and the predominance of the two latter gives a very peculiar appearance to the whole, as they do wherever they occur. On the opposite mainland they often resemble in colour the sandstone with which they are associated, so strongly, that it is impossible to distinguish the two rocks without a close examination. Occasionally, the harder varieties split in a schistose manner, forming a schistose clinkstone.

The structure is occasionally porphyritic, and sometimes amygdaloidal. There is nothing unusual in the porphyries, but the amygdaloids present some peculiarities worthy of notice. They frequently contain brown spar, often forming very large nodules; and it may be remarked that this substance is of rare occurrence in trap, when compared with the other minerals that occupy similar cavities. The form of the amygdaloidal cavity is more interesting than the imbedded substance. It is frequently elongated, and sometimes contorted; the surrounding solid parts also, giving indications of a corresponding texture. Where the

* Plate XXXIII. fig. 2.

imbedded nodules have been washed out, the interior of the cavity presents a peculiar appearance; exhibiting a fibrous and somewhat botryoidal surface, often further glazed with a slight vitrèous varnish.

In many cases the cavities are only encrusted with the matter of the nodule, the larger portion remaining empty; while, in some, they seem to have remained in this latter state from the commencement; being found unoccupied on breaking into those parts of the rock which are excluded from air and water. The specimens which present this character in a high degree, are conspicuous among the others from their cavernous structure. It is indeed often impossible to distinguish them from scoriform lavas, so identical are their characters with those of the volcanic rocks. Similar specimens occur among the trap in many other places, but they are rarely so perfect.

This is a subject of general and not of local interest in the history of the trap rocks, and one that has given rise to much discussion. It has been said that no instance of a trap strictly cavernous exists, but that in all cases the cavities are the result of the loss of those minerals which previously occupied them when they were in the form of amygdaloids. But such cavities are found deeply imbedded in solid rocks to which the weather can have had no access, and under circumstances where water could not have dissolved and removed an imbedded nodule. Such is the case here in a very remarkable degree.

That any other cause but the extrication of air should have produced these cavities is highly improbable, and, on the igneous view of the origin of these rocks, the existence of such a cause is sufficiently proved. Whether there is any necessity for admitting, generally, that the rocks of this tribe have been in a fluid state under great pressure, or not, it is here unnecessary to inquire; but it is sufficiently plain that in this particular case, whatever be the period and the place of fusion, the incumbent

weight has not been sufficient to prevent the extrication of air from the fluid mass. Out of many that might be quoted, I shall here add one more instance only of this fact, on account of its locality: the reasons for quoting it will immediately suggest themselves. It is in the rock of Edinburgh castle, in which similar cavities are found sparingly dispersed at a depth of many feet from the surface of the most solid masses. There appears indeed no reason to doubt that the amygdaloids in general bear marks of the same origin, and that the present substances which form their imbedded nodules, have been deposited by secretion or infiltration into cavities, in cases where the loose texture of the rock, and the materials of which it was composed, admitted of such solutions being formed; a process similar to that by which fissures in limestone and in schist are now daily filled. The examples of this nature on a large scale, formerly described in Rum, illustrate this opinion; as do numerous others quoted by foreign writers on similar subjects.

Among the other substances which occur in the amygdaloidal cavities, are nadelstein and red stilbite; but they are generally in minute nodules, and require no peculiar notice.

A more rare substance, which I have not observed any where else except on the adjoining coast, is an indurated steatite. It is sometimes found in nodules as large as a pea; more frequently they are of a smaller size. Their colour is green, varying from a pale greyish tone to a deep sap-green hue. Occasionally the exterior part of the nodule alone is hard, while the interior is soft and of a paler colour, and in a few instances it contains calcareous spar in the centre.

Green earth also occurs among these nodules, presenting considerable diversities of aspect. It appears a question yet undecided, whether the green earth of the trap rocks is the same mineral as the chlorite found in the primary strata, or whether even the chlorite of these

two classes of rock is the same. As this substance, under the several aspects in which it occurs in trap, has not been described, I shall here take the opportunity of enumerating all the varieties which have fallen under my notice.

When in the powdery form, it is seen varying from a muddy green, by a gradual change, to pure white, while it also occasionally passes to a bright yellow. When in the scaly form, in which it resembles common chlorite, it is sometimes found aggregated so as to fill the cavity, at others investing the surface only, in a botryoidal manner, or else projecting in laminar indefinite crystals into the interior. In these cases the colour passes from the common tint of chlorite to a darker hue scarcely distinguishable from black. More rarely, it is of a purple brown, as if it had undergone decomposition; of which, nevertheless, it gives no other indication, presenting, on the contrary, an unusual degree of hardness. In this case also it is generally crystallized. It is sometimes found without either the scaly or the pulverulent appearance; covering, like a varnish, the interior of a cavity, or the exterior of a nodule of calcareous spar or of some zeolite; in which cases it is frequently of a bright verdigris green. Lastly, it often occurs in stalactitic or arborescent forms; sometimes incrusted with a distinct deposit of chalcedony, subsequently imbedded in a solid mass of the same material, or else simply surrounded with the general matter of the chalcedonic nodule in which it lies; its progress being always easily traced from the including rock. In these cases the ramifications are often very minute and intricate; producing those well known ornamental substances often supposed to contain vegetable remains, and popularly distinguished by the name of moss agates.

AILSA.

Of the various objects which cause the scenery of the Clyde to rank among the most enticing tracts in Scotland, Ailsa stands foremost. Yet it has not hitherto excited that attention to which it is entitled; having been little visited, even by those to whom its vicinity renders it so easily accessible. To those whose pursuit is picturesque beauty alone, it has almost remained unknown. He who may hereafter profit by this hint, will not regret the time he may appropriate to this voyage: he will be amply repaid by the sight of scenery not surpassed, and rarely equalled, among the remoter Scottish isles.

In the distant horizon it forms an object peculiarly striking, from its unexpected magnitude in the blue haze, and from the decided and sudden manner in which it rises from the sea. In this respect it presents a solitary feature in Scotland, rather reminding the spectator of the volcanic islands of the distant Pacific ocean. The effect is often much increased by the position of the clouds, which so frequently involve its summit, adding indefinite and ideal dimensions to its altitude.

When viewed near at hand, Ailsa produces that peculiar effect which is the result of greatness of dimension combined with simplicity in the leading form and variety in the arrangement of the parts. In this respect its chief advantage is owing to the steepness of the acclivity; which enables the eye to comprehend the whole of its bulk even from a very short distance; thus giving it a mountainous effect often lost in the vicinity of much larger masses, in consequence of the foreshortening resulting from the lowness of their angles. While by its magnitude it thus fills the eye, the commodious distance at which it may be examined, enables the sight

to comprehend the variety and distribution of its parts, and to distinguish that intricacy of local colouring for which a certain degree of proximity is always required. It is partly owing to the beauty of the local colour, the mild tones of grey interspersed with greens of every tint, that the columnar ranges of Ailsa produce an effect so far superior to those of Staffa, of the Shiant isles, or of Sky; the uniform dark hue of these, without variety or contrast, often confounding the whole in indiscriminate gloom.

This island is situated in the firth of Clyde at nearly an equal distance from the shores of Ayr and Argyll, appearing like the summit of a vast mountain rising abruptly out of the deep. When viewed from the east or west, it has the figure of a right angled cone, while from the north or south it presents one considerably obtuse. This difference is the result of its form, which is that of a conoidal body with an irregularly elliptical basis. The altitude, as ascertained by trigonometrical measurement from a mean of numerous observations, is 1100 feet. The lateral dimensions cannot be computed by any ordinary means, as it is impossible either to traverse the ground or to make the circuit of the hill; but they may be estimated to a sufficient accuracy for general purposes, by comparing the lengths of its base with the measured altitude, from such a distance as to prevent any error from too low a position of the eye. This estimate gives its length about 3300 feet and its breadth 2200 or thereabout. The shore around is clean, and the water at a small distance so deep that ships may range it with safety; while, on the east side, a convenient landing place for boats is afforded by a spit of rolled pebbles that has been washed up by the alternate opposing run of the tide stream. This is the only point at which the rock can be ascended from the shore; the other sides being either perpendicular, or presenting rugged and unsurmountable acclivities. These, at the north side,

form an angle of forty-five degrees, and, at the south, one but little different; inclinations which, unless in very favourable circumstances of ground, may be considered as impracticable. The shores, if shores they may be called, which are found at the foot of this rock, are formed of the stones and rubbish that fall from the summit, and are, with the exception of the landing place above mentioned, so narrow, that although it is possible to land upon them in fine weather, they afford no view of the magnificent scenery which towers above them. For this purpose it is necessary to make the circuit in a boat; the summit of the island being not only difficult to traverse, but presenting, even when the laborious task has been executed, no sight of the perpendicular faces which constitute its most striking features.

On the east side, at about a fifth of the height, there is a sort of prolonged stair, or shoulder, on which are the remains of an ancient tower of strength, of a square form, and containing several vaulted chambers still entire. On this side, the hill continues to rise all round by various irregular stages to the top, which consists of an irregular longitudinal ridge lying north and south. The access is uncommonly laborious, not so much from its steepness, as from the fragments of rock with which it is overwhelmed, and the luxuriant vegetation of various tall plants which conceal their intervals and inequalities from the eye. The chief of these are the common nettle, the Silene amœna, and the Lychnis dioica; the two latter flourishing with unusual luxuriance, and producing, in the season of flowering, the most splendid effect. The grassy surface every where partakes of the same luxuriance of character, being occupied chiefly by rabbits, the commerce in which forms a principal part of its value. It is shared with them by a few goats in a state of almost primitive wildness; the neglected remains of herds to which it was formerly appropriated. Two springs of water are found on the eastern acclivity,

each producing a small marshy plain covered with plants of Hydrocotyle vulgaris, attaining, like all the plants found on this spot, an enormous size.

The perpendicular part of the rock extends from the south, round by the west, towards the north side, the greater portion being of a columnar form. Where it first commences, at the southern end, it is thirty or forty feet high, with a slight tendency to the columnar fracture. Further on, as the altitude of the cliffs increases, the columnar forms become more perfect, until a single face presents itself, attaining in a perpendicular position to a great height, and so divided as to exhibit, on a general view, an aspect of regularity equal to that of the well known columnar basalts of Scotland. The broken summits of the columns, huge fragments of which encumber the beach below, serve to give a variety that increases the general picturesque effect. These are the habitations and nests of the gannets, of which innumerable flocks annually breed here; forming, with the various tribes of gulls, puffins, auks, and other sea fowl, a feathered population scarcely exceeded by that of St. Kilda, or the Flannan isles. As the alarm occasioned by the arrival of a boat spreads itself, the whole of this noisy multitude takes wing, forming a cloud in the atmosphere which bears a striking resemblance to a fall of snow, or to the scattering of autumnal leaves in a storm. To prevent interference in their courses, each cloud of birds occupies a distinct stratum in the air, circulating in one direction and in a perpetual wheeling flight.

There are no ready means of measuring the length of the columns, but it may be estimated by comparing them from a sufficient distance with the total altitude of the island. By this estimate I should judge them to be upwards of 400 feet in height, an elevation before which the columns of Staffa, not reaching to sixty feet, sink into comparative insignificance. Although the total effect of this range is columnar, the pillars

are neither so perfectly defined nor so readily separable as those of Staffa; rather resembling those, more common throughout the Western islands, where the forms appear adhering, and occasionally, blended together. They are of a large size, the detached masses which are capable of being measured, reaching to six feet and upwards in diameter, their sides and angles being both variable and irregular. Although not jointed, they break, in most places, at right angles to their axes.

Proceeding further towards the north end of Ailsa, this high range of columns terminates in a jutting and small promontory, behind which is a recess containing a cave. This is about twelve feet in breadth and thirty in height, the depth being about fifty; and it terminates on the right hand in a kind of irregular dome. Though not remarkable for its size, the position and form render it extremely picturesque; various ranges of columns at different altitudes, and separated by irregular masses of rock, surrounding it and stretching away to the northward until they finally disappear. This part indeed presents the most picturesque subjects that Ailsa affords; the whole of the columnar face being visible at once if a proper point of distance be taken, and the simpler features and superior grandeur of the high ranges, forming a beautiful contrast with the more intricate disposition and complicated variety of the smaller.*

Ailsa is composed of a single rock, no difference being perceived between the amorphous and the columnar parts. The whole mass must be considered as one of the numerous modifications of the syenite of the trap family. It consists of an almost uniform basis of greyish compact felspar, occasionally tinged with a brownish or reddish hue, having small grains of quartz interspersed throughout. Together with that, it contains black spots, formed of very minute particles of horn-

* See Plate X.

blende collected in small groups and condensed towards a central point. It adds another variety to the list of those rocks which, like basalt, are capable of assuming a columnar form. Numerous trap veins traverse this rock. They are of considerable dimensions, and from the abrupt forms of the cliffs, expose their courses for a great space; presenting this geological fact in a very interesting view. The greater number are vertical, or at least highly erect, and they are attended with no disturbance or derangement of the surrounding rocks beyond that of simple separation; nor is there any alteration of either rock visible at the planes of contact.

Having so often noticed the picturesque scenes that have occurred in the different places described throughout this work, objects which have conduced to alleviate the toils and inconveniences that must attend every voyage through a climate so precarious, and a region so stormy, it would be unpardonable to conclude the description of the islands of the Clyde, without pointing out the extreme beauty of this river, from Dumbarton to its gradual and final termination in the open sea. The shores of the western boundary are every where characterized by cultivation, by woods, scattered trees, towns, and villas; displaying, with all the marks of wealth and high population, innumerable scenes of picturesque effect. On the opposite coast, the mountains of Argyllshire present the reverse character, that of wildness; the sea margin being still skirted by occasional patches of natural wood, and ornamented by the houses of the opulent proprietors. On this side, the intricate inlets of Loch Long, Loch Fyne, the Gare Loch, and numerous others, will conduct the traveller to all the varieties of mountain scenery which Argyllshire affords in perfection; these being occasionally further diversified by the castles of ancient times. Those narrow straits are often peculiarly striking from the height of the land immediately enclosing them, and from the pictu-

resque disposition of the rocky and woody precipices so often occurring along the shores; while their tortuous courses produce an ever changing variety of scenes. The islands alone present objects of endless diversity, whether examined in their interior or by coasting their shores; or, when forming parts of the distance, they combine with the perpetual variations of the surrounding land. If to all this be added the effects produced by the variable atmosphere of the western coast, and by the life and movement of the shipping that navigate the Clyde, it may without exaggeration be said that no portion of Scotland presents greater attractions to him whose pursuit is that of picturesque beauty.

GENERAL COMPARISON OF THE CLYDE ISLANDS.

In the former comparisons which have been drawn between the several members of the different groups into which the Western islands were distributed, it must have appeared that these associations were founded, rather on a mutual resemblance of character than on a common geographical bond. In the present instance, the general community of structure must be considered as pervading the whole conjointly; being only rendered discernible by viewing the several islands as parts of one great division, the several portions of which are, in a geological sense, mutually dependent on each other, although geographically discontinuous. The surrounding shores of the mainland present the same general structure; the several correspondences occurring on one part or another of the great æstuary of the Clyde in which these islands are embayed. Thus the present group becomes intimately connected with the adjoining continent; and, while the history of the several islands explains the relations and characters of the different strata on that shore, the more extensive continuity of the latter serves to restore to the islands that mutual dependence which is rendered less apparent in consequence of their disjunction. The geographical bond by which these islands are here united, is thus proved to be also a geological one; although at first less obvious than in the preceding cases where, on a general view, it appeared to be more intimate.

The general structure of that part of the mainland which corresponds to the islands of the Clyde, has already been mentioned in describing the schist of Bute. From that description it appears that the primary district of the Highlands is immediately followed by an extensive tract of red sandstone; the prolonged mutual boundary of

both passing through Bute with an undisturbed regularity, and extending also through Arran; but there subject to a derangement of which the cause has already been pointed out. That sandstone is the first of the secondary strata, and is covered by various portions of trap rocks of greater or less extent, which, notwithstanding, maintain a certain general parallelism to its north-western margin. Thus, as the northern portions of Bute and of Arran appertain to the primary strata of the continent, the Cumbrays and Sanda belong to the secondary; the greater Cumbray and Sanda containing the sandstone alone, while the lesser Cumbray presents an example of the trap which covers that rock on the mainland, and which forms so conspicuous a feature in the adjoining district of Ayrshire. By this comparison, the mutual dependence of the whole group is established; and it becomes easy in imagination so to fill up the present vacuities caused by the sea, as to restore the original connexions of all the islands.

It will be apparent on inspecting the general map, that the principal deficiency occurs in the space that should be occupied by the sandstone; and, in examining the connexions of these several rocks in a more detailed manner, the principal attention will be directed to that portion of the whole.

The granite of Arran presents, as before remarked, a solitary feature that admits of no comparison; as no analogous rock occurs on the mainland, in any position which would lead us to suppose a connexion existing between portions so widely separated. Nor are any further remarks on this rock necessary; its peculiar effect in disturbing the regularity of the strata having already been pointed out. As the general connexion of the schistose rocks was also necessarily discussed in illustrating the structure of Bute, any further remarks on these would be equally superfluous.

The peculiar circumstances of separation under which

the sandstone appears, are not limited solely to those parts which may be supposed to be covered by the sea, or to have been removed by its action; as similar appearances may be traced on the mainland. It is an interesting part of the history of that rock, and merits notice in itself, independently of the elucidation which it offers respecting the present state of these islands.

There can be no reason to doubt the identity of the whole deposit of red sandstone, from the east coast of Scotland even to the western side of Cantyre; as it possesses every where a set of common features, together with a common relation to the strata which it follows and to those which succeed it. But, throughout the whole of this tract, it presents a great variety both of dip and of direction; the angles of elevation varying in quantity, from the horizontal to a very high position, and respecting different points of the compass. Where the large tracts are examined, this variety of position is found to result from the general undulating manner in which it is disposed; depending apparently, in most cases, on the irregularity of the base on which it has been deposited; while in others, it seems to be the result of posterior changes which have at the same time affected the primary rocks beneath. Although the want of continuity prevents that undulating disposition from being traced to any great extent among the islands, there is reason to suppose that it has also existed, or that it even exists at present: but at so low a level as to permit the sea to flow over the strata. Thus their insulated state may to a certain degree be accounted for; although, in examining the present condition of these rocks in many places, it will be evident that a considerable loss of substance must also have taken place before the islands received their present forms. In comparing the actual inclinations of the secondary strata in the several islands, the existence of such an undulation is evident; and it is here unnecessary to recapitulate the particular instances in which it has been demonstrated. The effects of such a condition of

things will be rendered more obvious by approximating the parts and restoring the supposed continuity; and to aid this purpose an ideal section of that imaginary state is subjoined.*

For the further purpose of showing the loss of substance exhibited in various parts of this deposit in the vicinity of the islands, a similar section is also added; including part of Cantyre, where the marks of waste are the most unquestionable.† In the case of the islands, such losses would naturally be attributed to the action of the sea; but the analogous facts occurring in places where the sea does not reach, show that other causes must be allowed, to have shared at least, in producing those effects to which they probably owe much of their present forms.

A geological map of Cantyre would have been requisite to illustrate the very peculiar distribution of the sandstone in that district, but it is here inadmissible: the general map which accompanies this work will perhaps convey a sufficient idea of it for the present purpose. It must suffice, in addition, to remark, that a continuous tract of this rock extends along the eastern shore of that peninsula, from the harbour of Campbeltown southwards; and that to the north of that spot on the same shore, a few very minute detached portions are also found. On the western shore some independent masses of larger size occur; all of them presenting the same characters, both in composition, and in their relations to the micaceous schist on which they repose. Indications of their existence are even found extending across the low tract which intervenes between Campbeltown and Machrianish bay; and here their nature is further proved from their being followed by a portion of the same sandstone and coal that succeed to the red sandstone in the central tract of Scotland which lies between the Clyde and the Forth.

In describing the alluvia of Arran, it was remarked that

* Plate XXXIII. fig. 3. † Plate XXXIII. fig. 2.

the red sandstone was often covered by a great body of alluvial matter which appears to have arisen from its decomposition; remaining in the places in which it was formed. The same feature was then noticed as occurring in Cantyre. It is here indeed even more remarkable; as, independently of those alluvia which are still actually connected with subjacent bodies of the rock in this district, portions of it are to be found now unconnected with any rock; occupying the surface, without seeming to have undergone any transportation. From these several appearances, it may be concluded that the red sandstone of Cantyre once formed a more continuous mass; and that its present disjunction is to be traced to those gradual operations, already pointed out in treating of the great Cumbray, and also indicated in Arran, by which extensive tracts of the surface are decomposed, and often removed. The red alluvia appear to be the last remaining indications of the parts that formerly occupied the places where they are found; and it is not difficult to foresee, that in the further progress of time, the present insulated masses of that rock will terminate in that complete decomposition to which they are fast hastening, and ultimately perhaps disappear altogether.

As the identity of this mass of sandstone, throughout its whole course through Scotland, was shown, from these considerations its original continuity is also in a great degree demonstrated; and thus the islands of the Clyde become reunited to the peninsula of Cantyre, in a geological sense, as perfectly as they have been shown to be geologically continuous with the much greater tract to the north-east of their position.

The last rocks which require notice in this general comparison are those of the trap family.

In the introduction to the Trap isles, it was remarked that a very common connexion in place was found between those rocks and the secondary strata. That general re-

mark is confirmed here; not only by the position of the trap in the islands under review, but by the place which the analogous portions already noticed, occupy on the mainland. This association is in some points indeed very conspicuous in these islands. In Arran in particular, it was shown, that the Machrie river formed the mutual boundary, as far as it extended, between the primary and the secondary rocks; inasmuch at least as the principal mass of the latter was concerned. The same river is also the boundary of the trap rocks; none of which are found to pass it; nor, except in the form of veins, to intrude in the slightest degree on the primary strata. A striking instance of the nicety of this arrangement, occurs on the brow of a hill lying above the joint opening of Glen Rossie and Glen Shira, and not far from the source of the Machrie. A small mass of trap is here found, far detached from the prevailing portions, and lying on the very borders of the sandstone, just where it is about to terminate finally in the schists of the mountainous region; on which it does not intrude. The same remark may be made on Bute, where the trap is equally limited to the secondary division of the island.

On the mainland, a similar distribution will be found to prevail. The ranges of Fife, of the Ochils, the Sidlaw, the Pentland, the Campsie, with all the minor tracts of the same rock, are to be found equally connected with the secondary strata; sometimes immediately imposed on the red sandstone, in others on the later strata which lie above it. The same association will be found on the shores of Cantyre in the vicinity of Campbeltown. Considerable masses of porphyry, of which the rock of Devar is among the most conspicuous, occur in this tract; and in every instance they appear to be connected with the red sandstone or with the coal strata above it. Even in those cases where these masses are in contact at one part with the primary rocks, their larger portions will be found

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to repose on the sandstone or other secondary strata in the vicinity.

It will also be remembered that Morven presents a very remarkable instance of this association. Here, the trap appears to lie on the gneiss, but is rarely or never in actual contact with it; a body, however thin, of secondary strata being almost every where interposed. In Mull also it must have been observed, that the trap ceased at the Ross where the gneiss became visible; neither lying on that rock nor on the granite, but on those parts only where the existence of secondary rocks was either demonstrable or might fairly be inferred. Airdnamurchan is similarly constituted; the limits of the trap in that promontory appearing to be nearly, if not exactly, the same as those of the secondary strata which are there found. It is unnecessary, in confirmation of this remark, to repeat that which may be easily deduced from the descriptions of Sky or of the other islands where the overlying rocks occur.

Whatever may be judged of this circumstance of a prevailing association between the trap rocks and the secondary strata, it is by no means universal, and must not be esteemed a general rule. Even in Mull, the trap of Gribon rests partly on the primary strata of that shore. It has also been seen, in the account of the Slate isles, that although the trap of that district lies in many places on the secondary strata, it was, in others, in contact with the primary schists; in which state it also appears to exist in different parts of the adjoining mainland. In the former remarks on this subject, the porphyritic district of Glenco was pointed out as another exception; and that exception may be extended to the great mass of porphyry found in the northern parts of Argyllshire, which appears also to rest on the primary rocks.

In the article already alluded to, it was suggested that this phenomenon was difficult of explanation. Perhaps no real difficulty exists, and no necessary connexion between the two, even to the limited extent now apparent,

will be found. The apparent difficulty may arise solely from our ignorance of the changes which the surface has undergone. If the whole of the primary strata, for example, was once covered by the secondary, no portion of trap could now be found without being associated with the latter; since it is a rock of more recent origin. If a minor degree of the same order of things be conceived, it also follows that the trap rocks will proportionally be found prevailing above the secondary strata, and that this association does not indicate any necessary connexion between the two, but an incidental one only, due to the originally extensive spaces occupied by those strata.

It remains lastly, in comparing the strata of the several islands of the Clyde, to inquire if any connexion can be traced between the portions of coal occurring in Bute and Arran, and those of the adjoining mainland. So little of this substance is found in these islands, and the positions in which it occurs are so peculiar, that it is scarcely possible to institute such a comparison.

It is well known that an extensive tract of strata containing coal, reaches from the Clyde to the eastern sea. The general characters of this series are very simple when compared to those which appertain to the coal districts of England, but it is out of the bounds of this investigation to enter into their history. It is now necessary to remark, that on the western side of Cantyre, near Machrianish bay, a small portion of coal occurs, accompanied by the same strata that prevail in the great tract above mentioned, and bearing the same relation to the red sandstone. The linear prolongation of this tract to that one, passes through Bute and Arran, so as to include the coal of both these islands; thus appearing to indicate the same general continuity of this substance as of the red sandstone on which it lies. Here, however, the evidence of this continuity ceases; as the same accompanying strata and the same regularity do not exist in these islands. On the contrary, it has been seen that the coal of Arran

is included within the red sandstone, and, that in Bute, it lies between two masses of trap. Although the effects of the trap of Bute may be judged sufficient to have perverted the natural order of a portion of the regular coal strata, thus causing the present appearances, the same cause seems inapplicable to the case of Arran; unless it be also imagined that the upper red sandstone of this island is actually a portion of the strata peculiarly accompanying the coal elsewhere, which have here undergone a change in consequence of the causes already pointed out in describing that island. On this it is fruitless to speculate further.

In terminating this comparison of the Clyde islands, it is natural to inquire on what causes the present form of that æstuary depends: to what extent its present shape has resulted from the original disposition of the rocks which form its boundaries, and how far it may have been influenced by those posterior changes which consist in the removal of portions of the earth's surface. This is at all times an obscure subject; nor is there much satisfaction to be derived from investigating the several possibilities here involved in that question.

The irregular form, and the complicated nature of the æstuary of the Clyde are such, that it will be convenient to divide it into its two very obvious and dissimilar portions, before attempting to inquire into the probability that either of them has been produced, or materially altered in form, by the action of posterior causes. The Garroch head and the little Cumbray, constitute the natural limit between its narrow and wide parts; the latter forming a spacious bay, which communicates with the extensive inlet, Loch Fyne.

If we contemplate this great bay, in which Arran is situated, it will almost be evident that its form has been fundamentally determined by that of the surrounding land; by the ridges of hills which constitute its boundaries. This conclusion is founded on their general correspondence to the leading lines of the western shore, and on the

identity in the distribution of the hills and valleys, which seem equally in both cases to have determined the positions of those lines. The forms, indeed, of these sea lochs, and their intimate connexion with that æstuary, together with the obvious general causes which have determined the former, and the analogous ridges which bound the latter, point to one common origin for all these inlets; namely, that general cause which determined the form and direction of the islands and of the continent of Scotland.

It has however been shown, in describing the sandstone deposit of these islands, that it bore the marks of waste in a great degree; indications of which are found, not only in the partial occurrence of this rock in Cantyre, but in the cliffs of Arran and in the trap veins visible in the several islands; the persistence of which remain as records of the loss of the surrounding strata. There is therefore abundant proof that the original extent of these islands was more considerable, and their intimacy of position greater than it is at present; but whether we are justified in concluding that they ever were continuous, is a question on which it is hopeless to speculate.

I must here remark that no traces of the red sandstone are found within Loch Fyne; the northern limit of that rock being situated considerably to the south of its junction with the Clyde. If therefore the sandstone of Cantyre, Arran, Bute, and the mainland, were judged to have been once continuous, that extensive inlet must have been a fresh water lake discharging its waters through a channel between Bute and Arran, or between the latter island and Cantyre. But such discussions add nothing to the stock of our information. It must also be recollected, as already suggested, that as the sandstone has been shown to possess an undulating disposition, it is equally possible that the original distribution of that deposit has, like those of the ridges of primary mountains, been the cause of the present general form of the æstuary in this part of the Clyde, and of the

insular character of the detached portions which constitute the islands. That cause has at any rate been modified by posterior waste, and beyond that it is unnecessary to pursue this inquiry.

With respect to that part of this æstuary which lies to the north of the Garroch head, the same general reasoning may be applied, although this portion occupies a much smaller space. Here, it is true, the water lies, rather more decidedly, in a cavity of the sandstone, as that rock is found on both sides, although on the northern, interruptedly. At present however, whatever the former actions of the Clyde may have been, that river is employed in filling up the vacuity, not in deepening it. The alluvia brought down from the hills by the powerful streams which form this river, are fast extending the flat land at the point where it meets the sea; narrowing the navigation, shoaling the water far below Dumbarton, and laying the foundation of future meadows. The time will probably hereafter arrive, when the Clyde, like the Tay, will have filled up the whole tract to the north of Bute, and when the sea lochs included within this space will have become fresh; discharging their several rivers through the alluvial plains which will then separate them from the ocean.

*GARVH ISLAND. (DIURNESS.)

Although this small spot is unconnected with any of the groups into which the preceding isles were associated, and does not perhaps, in strictness, rank among the Western islands, I am induced to notice it on account of the peculiarity of the calcareous tract to which it belongs. Its geological interest will be found considerable, though its dimensions are insignificant; but as that interest is chiefly derived from a contemplation of the whole tract, it will be necessary to give a sketch of this as it occupies the inlets of Diurness and of Loch Eribol.

Garvh island lies off the entrance of Diurness bay, being of an irregular oval shape, not exceeding half a mile in its largest dimensions, and forming a table land surrounded on all sides by cliffs of about forty or fifty feet in elevation. It is about a mile from the nearest shore, and is not inhabited.

That shore consists of the red sandstone formerly described, but this island is an entire mass of limestone, corresponding with a tract of similar rock which lies, at the distance of less than two miles, on the west side of Diurness bay. This small tract consists of three rocky islets, called Eilan na gurach, and of a low ridge skirting the shore for about a mile and a half. The relative position and general correspondence of all these detached parts, indicate that they were once connected; and it will immediately be shown that they are related to a more extensive range of calcareous strata which occupy the east side of this bay.

The limestone of Garvh island, like that of the neighbouring tracts, is disposed in strata having a north-easterly

* Garrow in Arrowsmith's map. It could not be included in the map that accompanies this work.

direction, and dipping to the south-east in an angle of about fifteen degrees. In this latter circumstance it differs from the sandstone, which here dips to the north-west, although the direction of both is the same. Its relative position to the gneiss cannot be traced in this place, as the two rocks are separated in such a manner as to prevent an examination of their contact; nor is it very convenient to examine in the other parts of Diurness bay. It will hereafter, however, be seen that this defect is supplied by another calcareous tract of similar character situated in Loch Eribol, where the connexions admit of a free examination.

In colour, this limestone varies between different shades of grey, from a very light ash colour, to a leaden, and to a purplish tint. It is of a very fine texture and compact smooth fracture, sometimes approaching to the flat conchoidal. Interspersed among the ordinary beds are large concretions of pink and white carbonate of lime, which, when intermixed with the ordinary limestone, produce ornamental marbles. I could not detect any organic remains among these strata, although it will be seen that they exist in that portion of the same rock which occurs in Loch Eribol. But in the grey basis there are often found red vermicular stains, while the surfaces present on weathering, a variety of singular forms; both of these seeming to indicate that such remains originally entered into the composition of the rock; obscured here by posterior changes, as they appear to have been in Sky, and in the Isle of Man. The vermicular forms in particular are very similar to many that occur in the well-known marble of Babicomb, which are doubtless of organic origin. I need not point out the probable causes of these changes, as they are discussed elsewhere,[1] but shall proceed to elucidate the geological history of this island by a sketch of the calcareous tracts of Diurness and of Loch Eribol.

With the exception of the peninsula of Farout head, the

same limestone occupies the whole eastern side of Diurness loch, from the Grudy water to a point eastward of Bal na kiel, including Hoan island. Continuing to dip to the south-east, and being followed to the eastward, first by gneiss and successively by quartz rock, with similar dips, it is thus proved to lie beneath these two latter rocks. If any doubt could exist on this subject, it is removed by finding perfect natural sections of the same sequence in Loch Eribol, where the calcareous strata again occur in a similar order and in analogous situations. It presents here the same characters as in Garvh island; but among the beds there are also found portions of an obscure red colour, and of an aspect somewhat crystalline; the fracture, at least, being large granular, and the thin edges being imperfectly translucent. In certain parts it appears to contain a large proportion of silica, and in these cases the surface is sometimes coated with a crust of fine siliceous earth resembling tripoli, already noticed in speaking of the limestone of Ord in Sky; the calcareous matter appearing to have been dissolved by the rains so as to leave the insoluble earth behind in a semi-compact state.

In this tract are contained those extensive cavities which occur in the limestone of Derbyshire, and elsewhere, and which, it would thus appear, are not limited to the calcareous rocks of secondary formation. The cave of Smow presents a striking example of this circumstance; while it is no less interesting from its singularity and picturesque effect. The river of this name sinks suddenly into the earth at a small distance from the shore; and after holding a course underground, is heard falling in a dark cavity, whence it escapes by a narrow but invisible passage, into the outer cave, where it joins the sea. Of the innumerable caves on this coast it is the most singular; although far exceeded in grandeur of effect and in variety, by those which lie within the entrance of Loch Eribol.

From the termination of the mass of limestone thus described, to Loch Eribol, the whole space is occupied by gneiss and quartz rock, the west side of that inlet being entirely formed of the latter substance. The calcareous strata first appear in Eilan na Chorrie, situated towards its upper end, and are afterwards found skirting a portion of the eastern shore of the loch.

This island is entirely formed of limestone, similar in every respect to that already described, and maintaining the same direction and dip. On the shore of the loch, the sequence and contact of the adjoining rocks can be traced in different points, so as to give the most satisfactory evidence of their relations to the limestone as it there occurs. From the southernmost point where it is visible, to near Eribol house, the strata correspond in dip with those of the island, proving that they are a part of the same series, interrupted only by the sea. In proceeding northwards along the shore, their elevation increases, while the direction continues unaltered; until, at the point where the limestone finally terminates, they occupy an angle of eighty degrees. The flexure necessarily attending this change of elevation, is distinctly visible, both in the limestone and in the accompanying beds of quartz rock.

From the relative dips of these rocks and that of the gneiss which succeeds them, it might be readily deduced that the limestone was inferior to the gneiss; but a complete series of demonstrative evidence on this subject, can be obtained by tracing the eastern shore of Loch Eribol from the upper extremity to the Whiten head. The actual superposition of the quartz rock to the limestone, and that of the gneiss to the former, may be seen in various parts of the narrow tract that separates this bay from Loch Hope. Where the limestone is about to terminate, it is also found in actual alternation with the quartz rock; being here extenuated, and reduced to two strata that are separated by one bed of this sub-

stance, while they are also preceded and followed by it. The Whiten head affords an opportunity of tracing the superposition of the gneiss to the quartz rock, with similar exactness; a clear section, with the definite contact of the two, being there visible to those who will hazard the risk of landing on this dangerous and rocky shore. Thus the series of Loch Eribol consists of limestone succeeding to quartz rock and gneiss, and followed by the same substances in a regular order of superposition.

In retracing the whole of the series from Garvh island, the sequence is found to be as follows: gneiss, limestone, gneiss, quartz rock, limestone, quartz rock, gneiss; and to render the whole more intelligible a section is subjoined.* No hesitation can therefore exist in considering the limestone of this district as primary; since although any doubt should remain respecting the quartz rock, there can be none with regard to the gneiss; it being a part of that extensive mass which constitutes the greater portion of the north-west of Scotland.

In treating of Garvh island, I suggested the possibility of its rocks having once contained organic remains. In whatever light that conjecture may be viewed, their actual existence is ascertained in one of the beds of Loch Eribol. The rock in which they are found is not indeed calcareous, but the geological consequences that follow are the same, while the interest is rather increased by the peculiarity of its nature. It is a porous, or incompact, granular quartz, alternating with the beds of limestone, and appearing to have contained calcareous matter which has been subsequently removed from the surface, where alone it is accessible, by the rains; a case analogous to that of the limestone of Diurness before described. In this rock, conical bodies not exceeding a quarter of an inch in length, are seen imbedded; being evidently the fragments of

* Plate XXXII. fig. 1.

orthoceratites or some analogous fossil, possibly entire shells. On minute examination they prove to be cavities filled with a fine and loose powder of silica; the calcareous matter of the fossil having, as in the case of other silicated remains, disappeared, or possibly entered into some combination with the inclosing rock. The analogy of this series to that of the secondary sandstones alternating with limestone, in which organic remains also occur, must be obvious. There is little doubt that a more minute research would discover the same, or perhaps other fossils, in the calcareous beds also; but the nature of the country, and the position of the rocks, are such as to prevent any minute and profound investigation of this nature in a cursory visit. Whether these shall be discovered or not, it may be concluded that this orthoceratite, if such it be esteemed, is the most ancient organic fossil yet found; since the relative antiquity of this gneiss can admit of no doubt; it being a part of the great mass which forms the chief portion of the Highlands of Scotland, from Morven to Cape Wrath on the one hand, and to Cairn gorm and Inverness on the other.

It is thus consequently proved, that a member of a calcareous series, alternating with gneiss and succeeded by a vast body of that substance, contains organic remains; a character hitherto supposed to be limited to those strata, at furthest, of dubious relative date, which have been called *transition* strata. It will perhaps confirm this view to add, that in similar situations in Assynt, bituminous limestone occurs; the inflammable matter in this rock being with great reason supposed to have derived its origin from organized bodies.

The existence of organic remains among rocks not appertaining to the secondary class, however comparatively rare, is sufficiently common to prevent that circumstance from being made a criterion for distinguishing them from the primary. The well known expedient of a *transition* class has been adopted for the purpose

of comprising, among other rocks, those which contain evidences of the existence of marine animals prior to the deposition of the secondary strata; and this class, like the secondary, has been generally supposed definable by some boundary. Into the doubts respecting the propriety of this arrangement, it is not necessary here to enter formally; some have been occasionally pointed out as they occurred, which appear sufficient to prove that it is arbitrary; while as an artificial class, it does not seem conducive to any practical purposes, introducing confusion where it intends to establish regularity. This division has in fact no assignable boundary towards the primary strata; since that limit, if founded on the criterion above named, must be removed as often as an organic substance is discovered in a rock that is not secondary. Hence it has happened that most of the primary strata, either from containing such remains, or from being situated above rocks in which they exist, have, in some situation or other, become entitled to a place in this class, which thus loses the convenience even of an artificial distinction. With the exception of granite, it is not probable that geologists have yet discovered a rock beneath which organic remains may not be found. As they diminish in number, in a general sense, the further we recede from the most recent strata, it is plain that, among the lowermost rocks, they may occur so rarely as still to have escaped observation; a circumstance of which the chances would be increased by their more limited variety, more complete loss of texture and shape, and more simple forms. Their gradual disappearance in those cases where the secondary limestones assume the massive structure and crystalline texture, described in the account of Sky and of the Isle of Man, will illustrate this opinion, and suggest the possibility that even the common primary limestones may originally have contained organized bodies.

Perhaps when observations have been further multiplied, it may yet be ascertained, that there has been no portion of time during the deposition of the strati-

fied rocks, however ancient, in which animals have not existed. In concluding this subject, it is unnecessary to point out the importance of the preceding facts to geological science, and it is almost superfluous to say, that to account for them by calling this gneiss a *transition* rock, is merely to substitute a term which leaves the fact and its consequences precisely where they stood before.

ISLE OF MAN.*

THE general position and dimensions of this island, are sufficiently known to render unnecessary any further information on this subject than that which is to be procured by inspection of the map; the more so, as it remains one of the most imperfect parts of British geography, and a minute detail of particulars would therefore be merely a pretence to an accuracy which is unattainable. Fortunately, its geological details are so simple, and the limits of the rocks which compose it are so easily assigned with that degree of precision which is sufficient for an account of this nature, that, as far as the present objects are concerned, there is no reason to regret the imperfections of the present Map.

The Isle of Man is naturally divided into two distinct portions, as dissimilar in their general appearance as in their structure; the southern, and by far the larger part, consisting of an irregular group of mountainous land, and the northern, presenting an alluvial tract, for the most part flat, and in many places so level as to admit with difficulty of a sufficient drainage for the purposes of agriculture. The characters of the shores correspond, as might be expected, with that of the surface; being smooth and even where they bound the northern division, and rocky and indented, with few exceptions, throughout the whole of the larger southern district. Some variety nevertheless occurs, even in the shores of the northern division; since they terminate abruptly on the west side of the island by earthy cliffs, while on the east and north, they descend more gently to the gravelly beach which surrounds them. These

* See the Map.

distinct characters have doubtless been produced by some difference in the present and former action of the tides on those shores, which it would neither be very easy, nor perhaps very useful, to ascertain. The natural consequence of such a varying action is a variat on of the sea-line boundary, which appears however to be of little moment; while, at the same time, it is far too common a phenomenon in similar cases to require particular notice. From Ramsey to Douglas the eastern shore is rocky, with no exception but that of the sandy tract in Douglas bay. The cliffs are generally high and abrupt, and the sea in most instances skirts their bases, seldom allowing access to the shore for boats, except in the few places where creeks are found at the mouths of the small streams that flow down the eastern declivity of the mountain land. The valley of Laxey presents the largest sinuosity in this tract, forming a safe and convenient harbour for the boats employed in the herring fishery for which this island is so noted. The forms of the cliffs are determined by the direction of the beds, or at least by that of the fracture of the schist which constitutes them; and as their inclinations vary, so do their general effect and picturesque appearance, although these are seldom such as to render them interesting to the eye of a painter: they do not appear often to exceed 200 feet in elevation. The same character continues to Derby haven with little variety or interest; but at this point a sudden change takes place; the shores, although still rocky, becoming flat, and maintaining that character, with some variation from sandy beaches and rocks more or less elevated, as far as the southern side of Port la Marie point, where they again become abrupt and high, as on the eastern side of the island. Near Spanish head, the sections of the cliffs are vertical, and as they attain an altitude apparently not less than 300 feet, they assume considerable grandeur of character; the breadth and simplicity of fracture

which they present, materially enhancing that effect, for reasons which need not be suggested to those conversant in the principles of art. Here also a circumstance occurs, of some interest to the geological as to the general traveller.

Large portions of the land have been separated by vertical fissures extending from the surface almost to the level of the shore beneath, so deep and so dark that the eye does not penetrate to the bottom. The principal masses have thus slid into new positions, while many smaller fragments appear still suspended in the very act of falling; even the larger, seeming to be often so nicely poised that the hand would almost be thought sufficient to push them from their present situations into the sea that rolls below. The spectator who does not walk with fear over these chasms, must at least walk with caution; and will not perhaps at first easily divest himself of the sense of insecurity with which he traverses ground that appears in the act of escaping beneath his footsteps. In a physical view, the phenomenon is however much too common to require any explanation; while it is obviously a slide of no very distant origin, geologically considered. As an historical occurrence, it is of considerable antiquity; and although the distance in point of time cannot be ascertained, its lowest limit is recorded by the existence of a Druidical structure on one of the moved fragments; a chronological index, at least very remote, if not exactly to be assigned. The narrow and rocky channel which separates the Calf from the main island, with the boisterous tide that runs through it, and the high rocky shores that extend from this point to Brada head, will present much interesting scenery to those who may examine them from below; although from above, the points of sight are seldom picturesque. Hence to Peel, the same character, but with less grandeur, is preserved; after which, lower and less striking rocks, of different aspects, continue

with some interruption to skirt the shore till the mountain land terminates in the alluvial tract already described. The castle of Peel, more conspicuous for the extent and variety of its outline, than for the magnitude and style of its buildings, with the picturesque situation of its harbour and town, and the life produced by its shipping, forms an interesting object wherever it is visible in following this line of coast.

The general aspect of the interior of the island, is consonant to that of the coast now described. The northern alluvial tract is, throughout a great part, flat, while it is also in a high state of cultivation. One irregular range of low hills, formed of gravel, sand, and other similar matters, extends in a curved line along its northern and western edges; and I need scarcely add that, as it possesses but little wood, it offers no beauty to the traveller's eye beyond that which arises from the aspect of fertility, and from that of a scattered, and apparently wealthy, rural population. This indeed is a circumstance which will forcibly strike the English observer, who is accustomed to see large tracts, even when in high cultivation, occupied by a few opulent tenants whose houses are scarcely visible in the agricultural waste: it displays the remains of a system not yet conformed to that which is now fast establishing itself through the most improved parts of the British dominions. The features, whether of the mountainous or of the hilly tracts which form the elevated and southern part of the island, are various; but the two are in general readily distinguishable by the presence or absence of cultivation; although that has been here extended as far, perhaps in some instances further, than prudence would have dictated, or profit will ultimately justify. From the summit of Snaefell, which is the principal elevation of the Isle of Man, a tolerably accurate idea may be formed of the general distribution of the mountains, and of the relations of the several parts of the group. This

mountain, as it has been ascertained by trigonometrical observations, is 2004 feet high, and is accompanied by numerous other elevations gradually declining from that of North Barrule, the height of which is 200 feet less, down to the shores on each side of the principal group.

Notwithstanding the apparent division above alluded to, I must remark, that no real distinction exists between the hilly and the mountain land, since the latter declines into the former without break or interruption, by a succession of undulations becoming gradually lower as they approach the shores of the island. The forms of the mountains are invariably rounded and tame, as is most frequently the case in the schistose districts of Wales and Cumberland, and the rock is very rarely seen protruding so as to form abrupt faces; never in such a way as to give a rugged outline on the sky. No difference worthy of notice can be traced in the relative rapidity of the declivities on any of the hills which constitute the group; nor do the few broken faces which are to be seen, appear to respect one point of the compass rather than another.

On the north-eastern side of the island, the descent appears indeed more rapid than on the other parts of the group; and the difference is very remarkable if we compare the declivity which lies between Laxey and Ramsey, and includes St. Maughold's head, with that which descends towards Douglas, Peel, or Castle Town. But this circumstance does not affect the validity of the preceding remark; since it merely arises from the truncation of the group, (if it may so be called,) by the sea at this end of the island, being nearer to the highest elevations, and consequently from the absence of those lower hilly tracts which, on the other sides, skirt the principal mountainous district. In consequence of the gentle slope of this elevated land, the mountains are, as might be expected, wet and boggy; a covering of peat, amounting on an average to two feet in depth.

appearing to invest most parts of the elevated region. Except the Lycopodium alpinum and selaginoides, it produces no Alpine plants, and with the exception of Ophrys cordifolia, not a rare one to gratify the botanist's curiosity and vary the dreary uniformity of the surface.

The view from the summit of Snaefell is remarked for including the several parts of the British dominions; the ranges of Snowdon and of Cumberland being visible to the eastward and southward, the mountains of Morne, and Fairhead appearing on the west side, and the Mull of Galloway with the elevation of Criffel rising in the northern horizon. A distinct view of the island itself is also obtained; although the shores are in several directions excluded by the height of those hills which approach in elevation to the parent mountain. It is more interesting to the geologist to trace from this point the relations of the different hills to each other. Although the whole southern division of the island constitutes one group, it is evident that the several elevations are disposed in a linear direction, lying from the N. E. to the S. W. and thus forming a principal chain, with one inferior ridge on each side declining from the central line. Of the accuracy of this line the eye is not a competent judge, but it appears to extend in a very even manner between the points named. Hereafter, it is to be hoped, the construction of an accurate map will enable us to determine more precisely, that which can now be only described in a general manner. The positions and directions of hills, and more particularly of those which consist of stratified rocks, whether primary or secondary, and the relations which these bear in their several parts to the original positions of the strata, form an important question in physical geography.

The three main elevations which determine the position of the central chain are, Snaefell, North Barrule, and South Barrule. Ben y pot, North Greebah, South Greebah, Carraghan, Sartyl, and others, all lying between

1600 and 1300 feet of elevation, and more or less accurately in the same line, appertain to the same elevated and central range, which declines gradually, at the north-eastern end, in Cronk dhu, and at the south-western, in Slieu y carnan. The summits of these several hills do not however rise materially above the ridge itself which connects them. The inferior ridges which on each side decline from this leading one, are prolonged in directions tolerably parallel to it, with such deviations as might be expected, until they terminate, like that, in the shore, or in the flatter tract of Castle Rushen division. Mullach oure and Slieu learn, each of them reaching to 1500 feet or upwards, are the most elevated points of the south-eastern of these ranges, while Carden, Slieu dhu, and Caran form the chief prominencies on the north-western side. Neither of these ridges however is strongly distinguished from the central one; each being connected with the principal by high land, in the same way as the predominant summits in all the three ridges are by the intermediate parts. The transition from these higher elevations to the hilly land beneath, is gradual and imperceptible, as I have before remarked; no criterion being present to distinguish them, except the very irregular one formed by the boundary of agricultural improvement. The lower undulations are numerous and irregular, reaching the sea on all sides, except that which is bounded by the northern alluvial tract, and that where the flattish country forming Castle Rushen division intervenes. Scarcely a level spot of any extent is to be found throughout the whole of this range; the undulation of the ground being uninterrupted, and the hills succeeding each other with only small valleys interposed, the predominant tendency of which is at angles to the leading ridge. This part of the country is covered with inclosures, with scattered farm houses, and with cultivation; which, cramped as it must always be in a certain degree wherever small farms constitute a principal portion of the allotment of the land, is in every

respect on a par with its state in those districts of England where a similar division exists. The few trees which are to be found in the island, are to be seen chiefly in these valleys; and, thus sheltered, they thrive as well as in other similar situations on the western coasts of England. Whatever defects in this respect the island displays, have arisen from the neglect to which that branch of rural economy has been subjected almost every where throughout the British dominions until a recent period; and, here as elsewhere, they will be in time removed by the exertions which are making to restore this important part of the management of land to its due rank in rural affairs. Pleasing scenes, rarely such as can be styled picturesque, occur every where in these sheltered valleys; and when, in the progress of time, wood shall become more predominant, the Isle of Man will yield little in beauty to those parts of England or Scotland which are not characterized by the striking features of Cumberland and the Highland districts, or the extended magnificence of Kent and Somersetshire.

The valleys thus described, are not prolonged in their courses, and make no remarkable intersections in the mountain group. But there is one long valley between Douglas and Peel by which it is completely intersected, being at the same time divided nearly in the middle, and at right angles to the direction of the chain. The rivers of Peel and Douglas, collected in this valley, run to the sea in opposite directions. It is almost every where very narrow, the sides rising somewhat suddenly on each hand to the mountainous or hilly land by which it is bounded. At Peel, and still more remarkably at Douglas, it terminates in the sea by a narrow valley, producing at the former a prolonged basin which, by the erection of a parallel pier, has been converted into an excellent harbour for small vessels: at the latter is erected a double pier inclosing one of the best dry harbours in the Irish channel.

From this disposition of the land, the rivers of the Isle of Man are, as might be expected, rather numerous than extensive in their courses. Every small valley produces some stream, discharging itself into the sea or increasing the strength of some neighbouring river. Many of them are consequently too small to require notice, although, from the prevailing moisture of the climate, they are rarely dried up. The altitude of the mountain land is sufficient to intercept the track of the clouds during the greater part of the year; while its western position and insular situation ensure an almost constant supply of rain. The principal river of the island rises by numerous branches from the declivities which surround Snaefell, and passing in a tortuous course by Sulby, is discharged into the sea at Ramsey. The Bright river, which joins the Blackwater to form the inlet at Douglas, the rivers of Castletown, of Peel, of Laxey, and the Santon,* which marks the boundary of the limestone district on the eastern side, are the next most remarkable streams; but like the smaller, which it is unnecessary indeed even to enumerate, they require no particular description.

There is no reason to imagine that the form of the land has been any where materially modified by these rivers. If there is any one, the corrosive action of which might be suspected, from the depth and perpendicularity of the rocks which bound it near the termination, it is the Santon. But even this ravine may with equal facility have been determined by the position of the schist, in the same way as the irregular and undulating surface of the land has been. The rivers of this island have little power, and do not appear to have been concerned in effecting the present irregularities, which are more easily referred to the same distant but unknown operations by which the mountains themselves assumed their existing disposition. In a few instances, and perhaps most remarkably at Laxey, from

* A corruption of St. Ann.

the steepness of the declivity and the rapidity of the water, a quantity of rubbish, forming a beach of rounded pebbles, has been accumulated at the mouths of the streams: but it is generally insignificant in extent; making no permanent addition to the land, and producing no effect in changing the forms of the shores at the exits of the water. The operations of the mountain streams in some situations, and among others in the higher parts of Baldwin valley, upon the mountain alluvia, is rather more remarkable; since they are in these places skirted by the flat terraces of rubbish which so often accompany the course of a river that cuts its way through these accumulations of loose materials.

These alluvia are found on the lower parts of the slopes of the hills and in the bottoms of the valleys, all over the island. Their origin cannot apparently be traced, either to the present or former action of rivers; since they are equally deep and predominant even where water could never have flowed. Nor is there much evidence of a diluvian origin, a cause, the operations of which are so frequently to be traced in the mountainous parts of Scotland as well as on the great plains of England; and which may perhaps have given rise to another deposit in this island that will be immediately described. Such however may, at least in some degree, have been the origin of many of these and similar alluvia; for which, the gradual wearing and descent of the surfaces and summits of the hills towards the valleys, offer but an inadequate explanation. Without such a general cause, it is impossible to explain the existence of granite boulders; nor indeed of the rounded materials which enter into the alluvial deposits together with the angular fragments that appear to have undergone but a limited transportation; which latter, from their similarity of texture to the neighbouring rocks, appear to lie nearly in the places where they were formed. But I must leave this difficult question undetermined, and turn to another of the conspicuous parts

of the island where the operation of such a cause seems far less doubtful, nay, even probable.

This is the northern flat district already noticed in the general description, including the Curragh and the Balla chyrrim hills, and terminating on all sides in a shore of pebbles, or in an abrupt face of clay, sand, marle, and similar loose materials. There can be no question that such deposits have been formed from the ruin of solid rocks at some distant period; and nothing that is visible in the present structure of the land, nor any thing that can be imagined of its former shape, will justify us in supposing that the deposit in question has been produced by rivers formerly flowing from the summits of the present hills, or of any hills occupying their position. The presence of granite and porphyry in this alluvium, substances scarcely existing in the island, prove that they have been brought from distant points. If even any imaginary former altitude of the present mountains be assumed, the well known laws which predominate with respect to the relative positions of rocks, do not permit us to assign a place for the granite whence the granitic fragments should be derived, had they resulted from the decomposition of former mountains existing in the island. It will hereafter be seen, that the low position and small extent of the granite in this island, prevent it from offering an exception to the conclusion here drawn.

It is more probable that the alluvium in question has been the result of a general diluvian action, directed from the south towards the north, nearly in the present line of the channel which separates England from Ireland. Thus the deposit has been formed under the shelter of the hills; having been subsequently modified, in all probability, by various causes of more tedious operation; namely, by the effects of the tides, by the action of the currents as their position becomes gradually altered in consequence of their own attacks on the yielding materials of th bottom, and

by the usual waste and change which result from atmospheric actions and the gradual corrosion of rivers. At the present moment there is proof that the actions of the tides or currents are changing the form of the bottom. Sensible alterations are now taking place in the submarine banks which occupy the western channel between this island and England; and as a new one appears to be in the act of forming, according to the reports of those who navigate these seas, similar actions may have changed the general shape and outline of this alluvial tract from what it originally was, and may hereafter effect in it further alterations.* It was with a view to the position of this alluvium, indicating a current to the northwards, that a doubt was expressed respecting the diluvian origin of the deposits which occupy the interior valleys. They should in this case have respected the general current, and predominated in the same manner on those parts of the hills, which, as far as that current was concerned, may be called their lee sides. The observations are not easy to make, perhaps they have been ill made, and it is therefore possible that the intricacy in the arrangements of the hills and valleys, may have prevented this tendency from

* While on the subject of those changes which the action of the sea appears to have produced on the outline of this island, it is necessary to mention the discovery of a submerged wood in Pool vash bay. This was observed after a violent gale from the south, which, by removing the sand, disclosed the remains of a forest lying in a horizontal position, the trees having fallen towards the shore. Their nature could not be ascertained, as the texture of the wood was nearly destroyed; but it was said to resemble cedar in colour and softness. It might have been some harder wood which had undergone this change by the progress of decomposition. The phenomenon itself is not of uncommon occurrence, and, if its existence here cannot be satisfactorily explained, we must recollect that it has in other situations been attended by equal difficulties. I need not remind geologists of the other cases which have been recorded, nor of the speculations which have been resorted to for explaining some of the most obscure examples.

being conspicuous, while posterior waste may also have obliterated the small traces of them which once existed.

The substances which form the tract now under review, consist of marle, clay, sand, and gravel; neither of which are so interesting, either in their positions or details, as to require any very particular notice. The former is successfully used in agriculture; consisting of a mixture of clay with calcareous earth, and in some cases with fragments of limestone as well as of sand and mica, the ruins of those primary rocks which furnished the argillaceous ingredient. Shell marle does not appear to exist, and, in every case, the calcareous ingredient seems to have arisen, like the others, from the destruction of limestone rocks. The position of this calcareous ingredient, particularly where it occurs in fragments in the clay, is in some cases remarkable, and equally with the transported granite, points to a foreign origin. This is the case, among other places, in the alluvia in the vicinity of Douglas, where fragments of limestone are found imbedded in a position superior to that of the calcareous beds which occupy a tract on the southern side of the island. From this cause, among others, the clay of the Isle of Man, forming the basis of the soil which predominates in the cultivated districts, derives its excellence, and for the same reason it is generally rendered inapplicable to the purposes even of the coarsest pottery; the bricks formed from it cracking in the fire, in consequence of the calcination of the limestone.

The larger boulder stones, which are dispersed over the Isle of Man in various places, undoubtedly owe their origin to the general cause already stated, which they tend at the same time to confirm. Granite is the predominant substance among these, the different blocks presenting different varieties in composition. They are not often of very large size, but are cut by the inhabitants for millstones and for pillars, wherever they are of sufficient

magnitude and in accessible positions. Between Laxey and Ramsey, in the neighbourhood of the Doon river, they appear to have resulted from the ruin of the granite which is there found *in situ*, since they possess an absolute identity of composition with it, and differ from those which are scattered over other parts of the island. As they lie on the face of the hill above the present visible part of the fixed rock, it is probable that this granite extends to a much greater height in the mountains than can now be ascertained; and that some portions of it might be found higher up, uninvested with the schistose rock, if it were possible to remove the dense mass of alluvial matter by which it is covered.

Besides the granite, a few blocks of micaceous schist may be seen in one or two places; but of such a nature that they may possibly be portions of the hills on which they lie, since the intermixture of clay slate and micaceous schist is by no means uncommon, as may be deduced from several parts of the preceding descriptions.

Such are the most interesting phenomena which relate to the alluvial matters found in the Isle of Man, and such the very slender train of reasoning towards the establishment of general results, which may be deduced from them. But various other extraneous and transported substances occur in different parts of the island; and as the account of them is too little interesting to require a separate section, it will be preferable to make cursory mention of them here. Whether such substances, generally found on the shores, have been brought among the ballast of ships, or thrown up by the wash of the sea, from distant rocks, is almost equally indifferent for the purposes of geology.

The scattered masses of different porphyries which are seen in considerable abundance on the north end of the island, must perhaps be referred to the general cause which deposited the alluvia; since they are also found,

although very sparingly dispersed, in different parts of the interior. Several modifications of hornblende schist, and of argillaceous schist with distinctly imbedded crystals of hornblende, occur also in similar situations. It is even possible that the numerous substances, which are now only to be seen on the shores where the tide washes them up, are the remains of the general alluvial deposit, thus brought from their submarine habitations, like the jaspers and agates which abound on the eastern coasts of Scotland. The greatest variety of these rolled pebbles is to be observed on the western shore, and they abound in the vicinity of Peel. Jaspers of various colours, quartz, porphyries, and granites, are the predominant substances. Pebbles of chalcedony, similar to those formed in trap rocks, are also to be seen, and these are collected by the natives for the purposes of ornament.

A VERY slight topographical sketch of the rocks which form the Isle of Man, will be sufficient for the purpose of preceding the geological details; and, as they are disposed in a very simple manner, these details will hereafter be attended with little geographical confusion.

The inspection of the coloured map will assist the reader in comprehending their situations and general boundaries.

Granite occurs in one situation in the immediate vicinity of the Doon river, at a very short distance from the road side, between Laxey and Ramsey. The quantity exposed does not extend to many yards, and having been subjected to the action of water, it is every where decomposed. It was also observed in Foxdale mine, when that was formerly wrought, but there is now no opportunity of ascertaining its existence.

It will be readily perceived on inspection of the map, that the principal part of the island is composed of schist, which occupies at least five-sixths of the surface. The boundary of this rock, on the northern side, is the allu-

vial tract already described. On every other, with the two exceptions which will presently be stated, it terminates in the sea. This mass of schist presents several varieties, and is in many instances applied to economical purposes. These I shall here state; referring to a distinct place, the account of its geological relations and mineralogical characters.

It is every where obvious that the more tender varieties are in a state of rapid decomposition, and that they are converted, in the last stage of this process, into the clay which forms the leading division of the agricultural soil of the island. These clays differ in aspect and composition; as do the rocks whence they are derived; their colour varying in proportion to the quantity of iron contained in the original rock, and according to the degree of change that metal has undergone during the progress of decomposition: their ingredients also differ more or less, as quartz, mica, or calcareous earth, have taken a part in their formation. Hence the several soils resulting from them vary materially; more however to the experience of the agriculturist than to the eye of the mineralogist.

Fissile slate is not very abundant among these rocks, but it appears in different places. It has been wrought at Balla gawn, in the neighbourhood of Peel, and possibly in other situations which did not fall under my inspection. In many places, and among others at Laxey, the fissile varieties are thick, and excellently adapted for the purpose of flags; containing much quartz, and bearing a considerable resemblance to those which are found in Isla at the places where the quartz rock and the clay slate approach each other. The size of such flag slate, when in its native place, is sometimes enormous; large plates of twenty or thirty feet in dimensions, or even more, being visible in many parts of the island. No attempt is however made to raise these entire; there being no demand for specimens so large. They are generally

broken in the act of quarrying, and applied to the purposes of building stone; the flatness of their surfaces, and the angles of their joints, adapting them particularly to dry stone work, as well as to the ordinary objects of masonry.

A more rare variety of schist, applicable, like the former, to economical purposes, occurs at Spanish head and in its vicinity, where quarries have been opened. It is of a fibrous texture, and is capable of being raised in long beams, extending from twelve, even to eighteen feet in length. These are used for lintels, and similar objects, and are admirably adapted for many other architectural purposes, too obvious to require mention. As yet they have not become the subjects of export; the duties on the internal commerce in stone, producing here, as in so many other instances, the effect of a prohibition. They possess a property not often observed in rocks, namely, that of flexibility; returning to their places, like other elastic substances, when the bending force has been removed. In some trials, made for this purpose, it was found that a beam of fifteen feet in length was forced five inches out of the straight line before it broke; its thickness being two inches.

Among the other economical varieties of schist, a kind of hone slate occurs at a place called Montpellier. It is of a whitish colour and soft texture, better adapted for the polishing of metallic plates than the uses of the cutler. It has not been exported.

The last variety of this rock which it seems necessary to notice at present, is drawing slate. This is to be seen near Peel, at the point where the junction of the red sandstone with the schist is visible. The specimens which I procured were not of a very good quality, but as the bed is of considerable thickness and varies much in its texture in different parts, it is possible that, with a patient research, better might be found. This substance forms also

a good substitute for other colours as a paint in oil; but, being unknown to the inhabitants, it has not been applied to any purposes.

The next most extensive and important rock after the schist, is the limestone. The boundary of the principal mass cannot every where be defined with absolute precision, since in the interior parts it is covered with a deep soil. This however is easily done on the shore, and it is indicated in the accompanying map; while, by tracing its termination in the schist near Ballasalla, its limit at that place is also determined. The intermediate line on each side of that point, towards the Santon river on one hand and Pool vash on the other, is laid down as well as the map would allow, from a consideration of the form of the land; since there is a sensible difference between the undulation of the surface above the limestone, and that above the schist. A small detached piece also occurs on the point near Port la Marie, which is there, like the former, capable of being accurately defined, since its junction with the schist is visible on both sides.

There are two very different kinds of limestone in these places, and there are also several varieties of each of them, to which more or less importance in an economical view is attached. The two leading distinctions are, a stratified limestone containing shells, and an unstratified and irregular one rarely containing any, and commonly of a crystalline texture. These are mixed in an irregular manner over the whole tract; a mass of the unstratified rock occurring unexpectedly in the midst of the stratified, without any certain order or arrangement. In general, all the varieties of the unstratified rock are rejected by agriculturists. In some cases it seems to have been ascertained that they are ill adapted for land; in others it has been so imagined without sufficient trial. There is another objection to the use of the unstratified limestone, arising from the greater difficulty of quarrying it; while it is also less easy to burn. Differences in

mineral composition will explain the causes of these variations. I may here remark, that, in many instances, these varieties present an ornamental disposition of colour, some of the rocks also, consisting of breccias of considerable beauty; but their irregularity, their hardness, and the numerous fissures by which they are intersected, prevent any temptation to work them as marbles.

The chief variations in the stratified limestone are those in the colour, in the quantity of organic remains which it contains, in the greater or less admixture of argillaceous and siliceous earths, and in the quantity of shale which occurs interlaminated with the beds. In consequence of these variations, the different beds are more or less adapted to the several purposes, whether of mortar, or of agriculture, and different quarries are accordingly opened in various places, to which, according to the purity of the produce, more or less value is attached. Those of Balla salla are by far the most extensive; but it is unnecessary to enumerate all the quarries which have actually been wrought.

At Pool vash, and within extreme high-water mark, is found a series of beds, of a very dark colour approaching to black, which have long been wrought as marble. They possess a sort of historical celebrity from having furnished the steps which ascend to the entrance of St. Paul's Cathedral, a present, as is well known, from the bishop of this diocese. They are now wrought for gravestones only, since they are, from their argillaceous nature, incapable of receiving a polish.

The next and last rock is a small tract of red sandstone, which, on account of its insignificant geographic extent, is here described last, although, in a geological view, it must rank before the limestone. It commences about half a mile to the north of Peel, at the end of a small sandy bay, and is continued along the shore for the space of about two miles, where it terminates, being immediately succeeded by the schist already described. Its

interior extent seems never to exceed half a mile, but the boundary must remain conjectural, since it scarcely appears at the surface and has not been there quarried. This judgment respecting its boundary is only founded on the external form of the land. It contains one or two small patches, or portions of beds, of white sandstone, but of no value: the red, being compact, easily quarried, and raised in large blocks, has been used for building.

Such is a brief and popular view of the rocks which are found in the Isle of Man.

In proceeding to those scientific details more peculiarly interesting to geologists, I shall, as on other occasions, describe the rocks according to their superposition; that order which, whenever it can be followed, is by far the most instructive and intelligible.*

The granite already mentioned is situated two or three hundred feet above the sea, on a steep declivity, and has been laid bare in one place by a small farm road, in another by the mountain stream which has worn a deep channel in it. Unfortunately, the place where it appears is surrounded by various small streams, and lies under a rapid slope of the mountains; from which causes perhaps, among others, it is every where so overwhelmed by alluvial matter as to be completely insulated among a mass of rubbish. This accumulation is so extensive and at the same time so deep, since it in many places exceeds twenty or thirty feet, that the schist is no where visible in the vicinity of the granite. The streams, which have caused such deep channels, have not yet succeeded in reaching the solid rock, except at the point just described; the masses of granite, which occur at the small bridge over the Doon river, being transported blocks; not the fixed rock, as they appear to be on a superficial view. No information can therefore be obtained respecting the

* The Sections, Plate XXXII. fig. 6, 7, will serve to explain the general relations of all the rocks of the island.

junction of the granite and the schist, nor can it be determined whether the former substance is part of a fundamental mass or an exposed portion of a vein. On this subject it can only be remarked, that the structure of the granite is even, and small grained; and that it resembles in general aspect those which are known to form fundamental rocks; being totally unlike that which, in Scotland at least, is found in independent veins, and which is there always characterized by a peculiarity of structure. In describing the alluvial rocks, it was already hinted that the granite might possibly extend to a much greater height in the mountain; from the great number of rolled pieces and angular fragments which are found in a position far superior, and which are identical in structure with it, while they at the same time differ materially from those demonstrably transported blocks found in different parts of the island. Hereafter perhaps, some accidental increase of a mountain torrent may, by sweeping off the alluvial covering, lay bare a larger extent at a higher elevation, and confirm this conjecture.

Although the actual contact of the schist and granite is no where visible, there are indications present to show that this contact is probably not remote from the spot where the latter appears. In the rolled fragments are found pieces of schist entangled in the granite; which, when large, preserve their usual character, and when small, put on the aspect of micaceous schist: minute fragments of these are even found in the fixed rock. I have already mentioned this phenomenon as occurring in Mull, in Rannoch, in Braemar, and in Glenco. In all these cases, this appearance is limited to the vicinity of the schist; and it thus becomes probable, that here also, the junction of the schist and the granite takes place in the vicinity of the Doon river.

Felspar and mica predominate in the composition of this granite; the quartz is in small quantity. The felspar is of a brownish hue, and the mica is white or grey. In

the decomposed rock, the former is convreted into a yellow clay, and the latter into a greyish one. In addition to this, small strings and fragments of a fine dark clay are found in it. These appear to result from the decomposition of the entangled fragments of schist already described, and have been sought after with some anxiety for the purpose of a polishing powder: they form the Dun earth of the islanders. The mode in which the granite decomposes, is not very common: at the same time it is well known to geologists. In trap, this mode of decomposition is frequent, and is not the only point of resemblance which occurs between the older and the most recent unstratified rocks. Although the general mass of the rock is at first uniform, and apparently homogeneous, the commencement of decomposition is marked by circular lines which respect a central nucleus, or rather different centres. A section exposes the whole process, which takes place without the contact of air. While the parts most distant from the centre of each nucleus, are completely detached in successive crusts and converted into clay, lines, gradually becoming more feeble, are found marked in succession towards the centre, where the solid rock, ultimately destined to undergo the same change, is still in a state of integrity.* The intervals between these irregularly globular bodies are occupied by curved and by straight lines, the granite in certain parts decomposing in schistose laminæ. In a general view there is nothing to be remarked on this subject which has not frequently been discussed already, and the appearance in this case, as in that of trap, has been by all geologists referred to the concretionary structure. But a circumstance, which has recently occurred in my observations, proves that in certain cases at least, the exfoliation of granite is independent of any internal structure. It was already alluded to on a former occasion.

* Plate XXVIII. fig. 3.

Among the granite columns lately brought from Leptis, and now in the British museum, it may be remarked that many are decomposing in crusts concentric to the axis of the shaft; each crust varying from one-sixth to one-fourth of an inch in thickness, and still possessing considerable tenacity, with an appearance scarcely changed from that of the fresher specimens. However difficult it may be to explain this mode of decomposition, it appears quite similar to that which occurs, in many cases, in natural blocks of granite, as well as in the trap rocks; and may perhaps, in some measure invalidate, not only the preceding opinions, but, to a certain degree also, the observations formerly made respecting the schistose granite of Arran, where a reference was made to this fact.

The next rock in order to the granite is the argillaceous schist, the general extent and disposition of which have already been stated. In describing the leading features and relations of this mass, the general term of schist has been adopted; since the whole, though differing in many places in mineral composition, bears a common relation to the rocks which follow it, and doubtless also to that which precedes. With such a term, the history of this body of strata will be more intelligible, and the general bearings of the whole more easily apprehended, than if, in describing it, the several varieties were considered separately; a mode calculated not only to produce a tedious repetition, but in danger of conveying fallacious ideas respecting its character. As on former occasions, it will be more consistent with clearness of description to consider these several varieties as so many mineralogical distinctions; taking care to notice their relations to the general mass wherever they are such as to present any useful information, or where they tend to illustrate the history of the argillaceous schists.

This proceeding appears the more necessary, since, as was already hinted in the account of Bute, some obscurity appears occasionally to have been produced by confound-

ing two circumstances which ought, as far as possible, always to be distinguished in description, namely, the geological connexions and the mineralogical characters, or by deducing the former as a necessary consequence from the latter. With respect to the particular class of rocks under review, namely, the argillaceous schists of the primary class, a practice has prevailed, with what propriety appears doubtful, of making geological divisions where Nature appears only to have made mineralogical distinctions, and of founding essential characters on circumstances which ought perhaps only to be considered as accidental. In the case of micaceous schist, a class of rocks of as great frequency and extent as the argillaceous schists, and exhibiting varieties in composition much greater than those which occur among the latter, no such division has been thought necessary; every variety occurring in this series being admitted to stand in a common relation to the surrounding rocks, although differing from each other in a much greater degree than fine clay slate does from those coarse varieties which have been designated by the term graywacké. If it is judged expedient by geologists that the same practice should be extended to the rocks immediately under review, the confusion which has hitherto so often attended them will probably be removed, and the history of the argillaceous schists reduced to that simplicity so much to be desired in these investigations.

It is unnecessary here to repeat the different observations scattered throughout this work, which form the arguments for the view now taken of the common relation in which all the argillaceous schists stand to each other and to the surrounding rocks. These are supported by the examples of Cornwall, Wales, and Cumberland; the structure of which countries resembles that of the Isle of Man, and in all of which the several argillaceous schists form part of a common deposit. It is certain that graywacké is often predominant, that it is even sometimes exclusive; yet, in those cases also, it maintains the same

connexion with the rocks that precede and follow it. As already remarked in the account of Bute, if any such series can be ascertained, which is distinct in geological characters, both from the primary and secondary rocks, it would be advantageous to confer on it a specific designation; but even then it would be necessary so to distinguish it by an appropriate term, as to prevent any confusion from applying that of graywacké in a double sense.

It is evident that the presence of organic remains does not distinguish between clay slate and graywacké, as they are found in those deposits which contain both these rocks. Neither does this form a constant geological distinction, even in the graywacké, as they are frequently absent in those districts which have been assigned to the class of *transition* rocks. It appears difficult, indeed, to discover what are the characteristics of a class which is to be defined by circumstances that are only occasional, which occupies the same positions and maintains the same relations to the associated rocks as the primary, and which does not form an intermediate member between the primary and secondary strata, since it is often altogether absent.

This is not however the place to discuss so important a geological question. It is sufficient to have thrown out these hints to geologists of more experience, to whose consideration they must now be left, while I proceed to describe the structure of the island under review.

Assuming now, that which will shortly be proved, namely, that the schist of the Isle of Man constitutes a single mass, its character as a primary rock is determined by its position with respect to the granite, since it immediately follows that rock. This is therefore another instance, in addition to those already known in our own country, of the immediate succession of argillaceous schist to granite, a fact too common to require any remarks on the inconstant order in which the primary strata succeed that fundamental substance.

The next question respecting the schist is, whether its

position in different places bears any relation to the granite mass, or rather to the forms of the mountains; since the quantity of granite here visible is too trifling to admit of any comparison of this nature. To determine this point, it would be necessary to assign the positions of the strata on different sides of the mountain range; an object which renders it first indispensable to ascertain to what extent proofs of the stratification of the schist can here be obtained.

The indications of this order are seen in many instances so distinctly, that no doubt can be entertained respecting the stratified nature of argillaceous schist. But the disposition of the strata, as formerly observed, is sometimes easily confounded with that of the laminar structure, which is not always coincident, but is, on the contrary, sometimes placed at considerable angles with the plane of stratification. This error is easily committed in examining the schist of this island, but it may be corrected by careful examination. But that examination, although sufficient to determine that the laminar tendency of the schist is here often different from the plane of stratification, has not enabled me to assign the real positions of the strata, if indeed they can be discovered to such an extent as to determine the object in question, namely, the relation of the strata to the forms of the mountains. To understand this part of the subject, however, it is necessary first to describe the schist in some detail, and thus to state the causes of this uncertainty.

The substances which appear to be predominant in the general mass, are those which mineralogists have agreed to rank with clay slate; although many of them differ materially in their composition and appearance, from the best defined specimens of that rock. Together with these, there occurs, but in comparatively small quantity, that schist distinguished by the term graywacké; generally of a fine texture, and presenting a much more limited variety of appearance than is usual in similar situations. It is found

either massive or fissile, or appears under the two modifications of graywacké and graywacké slate.

This rock, in its different forms, is found in every part of the island, but the massive is every where more rare than the fissile. Wherever it occurs, it is irregularly interposed among the clay slate, often in portions extremely small, sometimes forming larger tracts, and therefore alternating with it in an irregular manner. This alternation appears, in some cases, to take place by beds; in others, the portions of the graywacké mixed with the clay slate, are so irregular and so dispersed, that it is impossible to determine whether or not they possess any fixed relation to it. Examples of these occurrences are so numerous, that it is superfluous to enumerate them: I shall describe only two, because of their distinctness and of the facility with which they may be examined by those who may be so inclined.

Where the junction of the red sandstone with the primary rock at Peel takes place, a fine fissile clay slate is found in immediate contact with the sandstone. A few thin beds of a non-fissile graywacké, extremely reticulated by veins of quartz, alternate with this slate; and it may be remarked that the quartz veins are limited to the former, never passing into the latter. The graywacké breaks into irregular angular fragments, having no apparent relation to the general fracture of the schist. In the same place, a repeated alternation is also visible, of an extremely fine and soft clay slate, of a blue and of a black colour, with a similar graywacké. The clay slate is in thin beds, which are prolonged, and, as it were, compressed between the graywacké; being at the same time bent or twisted, so as to put on the deceptive appearance of veins.* The unequal action of the sea and weather on these two substances, renders this

* Plate XXVIII. fig. 2.

appearance very conspicuous. There can be no doubt of the nature of the rocks engaged in these alternations, as one of the beds of slate contains the black chalk, or drawing slate, which was mentioned in the general description.

I need take no notice of the flexion and apparent compression of the clay slate in this instance, as I can add nothing to what I have on former occasions remarked on this subject.

The next instance is to be seen in the vicinity of Douglas. Here, the clay slate is also the predominant substance, and is disposed in laminæ at a high angle, often nearly vertical, and of great extent. These, from their magnitude, convey the idea of beds. In examining them more narrowly, a belt of rock, resembling at first sight a trap vein, is seen crossing them in a nearly horizontal direction. On investigation, this is found to be a mass of graywacké, not divided by any fissure or discontinuity from the slate, which lies above and below it; although when broken, the one rock readily separates from the other. The fissility of the slaty rock is in this place very remarkable, since it is easily split into large tables, and also exfoliates naturally in flakes of extreme thinness. But this fissile quality is interrupted at the place where the graywacké appears, being again renewed as before, above it; the breadth of the graywacké zone not exceeding two or three feet. The fracture of this latter is angular and irregular, without the slightest appearance of a slaty structure, and its texture is rather fine-grained. The subjoined sketch will afford a clearer elucidation of this circumstance.*

It will be rendered more intelligible by calling to mind a similar circumstance occurring in Isla, and already described, as the one will serve to illustrate the other. In the present example, the fissility is indeed suspended

Plate XXVIII. fig. 1.

where the band of graywacké appears, although, in Isla, it extends through both; but there is no difficulty in explaining this circumstance, when it is recollected that many of the graywackés occurring with clay slate, are of a solid and non-fissile structure. The band in question may therefore be considered as the edge of a bed of this rock, deposited in alternating order with the clay slate. This bed, on the foregoing principles, will therefore serve to determine the position of the great strata of schist, of which the seams are here invisible; and they will thus be found to lie nearly at right angles to the direction of the fissile tendency. Instead therefore of considering the schist in the neighbourhood of Douglas as placed in an erect position, it must be considered as disposed in horizontal beds; and, if the same rule could be proved to hold good every where in this island, we must in every instance reverse the most obvious appearances; considering the beds to be erect where the fissile tendency is horizontal, and horizontal where this is erect. Such an universal conclusion however would not be justified; but these considerations inculcate the necessity of caution in assigning the positions of the beds of schist, unless, either the indications just mentioned are visible, or the positive existence of the seams is ascertained.

The seams themselves are visible near Spanish head, and they are horizontal or nearly so; while they are at the same time slightly undulated: but there is here no ready access to them, so as to determine at what angle the fissile tendency lies. In most other parts of the island, extreme confusion in the fissility is visible, but the seams of the beds are scarcely ever to be discovered. If we cannot safely conclude from this circumstance, that the beds themselves are disposed in an undulating and irregular manner, that point must remain unsettled, since there are no other indications from which to form a judgment.

In now reverting to the original question, namely, whether the beds of schist bore any relation to the exterior forms of the mountains, and whether their irregularities have determined the disposition of the group, it is evident that no light can be thrown on the subject, unless future observers shall determine, throughout the mountains, that disposition of the beds which eluded my examination. The laminar tendency is obviously incapable of furnishing any unexceptionable evidence on this subject. Yet the preceding discussion will not, imperfect as it is, be without its use, since it will point out some of the causes which prevent the solution of similar questions in other cases, and excite useful doubts whether, in many instances, general conclusions to this effect have not been founded on imperfect views of the nature and bearings of the schistose rocks.

As it is in vain to endeavour to convey an idea of the varieties of rocks by description, I shall content myself with a very superficial notice of the principal modifications of schist occurring in the Isle of Man; enumerating rather their leading features than attempting to describe individual specimens. Such as are applicable to useful purposes, have been already sufficiently pointed out in the topographical part of this article.

The clay slate appears frequently in its simplest form, as a soft fissile uniform substance, of different colours, passing from a greyish white through various darker tints to lead blue, and ultimately to an imperfect black. In certain cases it possesses a silky appearance, approaching at times to a plumbaginous lustre; and, these appearances by degrees increasing, it assumes the aspect of a fine micaceous, and of a talcy slate. In structure, it is occasionally fibrous, and this variety predominates at the southern end of the island, while in other cases it shows neither fibrous nor foliated tendency. It is proper to remark that these varieties are found indif-

ferently in all parts of the island, on the shores as on the summits of the highest mountains.

In certain cases the clay slate contains a greater proportion of siliceous matter, which, according to the mode of its disposition, produces numerous other modifications. The whole acquires at times a flinty hardness with an uniform aspect, and, in proportion to the increase of the siliceous ingredient, becomes at length converted into a quartzose clay slate, a substance well known to accompany ordinary slate in other situations, and not unfrequently confounded with indurated schist, or flinty slate, as it is called. Where the grains of quartz are distinct, it acquires a coarser texture, and thus passes gradually into a graywacké, or at least into a substance which cannot, either by aspect or definition, be distinguished from it. Interspersed grains of mica occasionally diversify these varieties still further, but a sufficient idea of them has already been given. To describe the more extensive masses of graywacké in all their modifications, would be superfluous.

It is almost equally unnecessary to say that the whole of these schists are every where traversed by veins of quartz. One detached and solitary fact occurred during the examination of the schist, which must not be passed over; although most geologists will now consider the argument which it offers respecting the mechanical deposition of argillaceous schist as superfluous. It was that of a rounded pebble imbedded in the clay slate, at the mouth of the Santon river. This was of an oval shape, evidently rounded by mechanical action, and decomposed on the surface; consisting of a harder variety of clay slate with a few interspersed grains of hornblende. It has on other occasions been shown that the other two leading members of the primary strata, namely, quartz rock and micaceous schist, sometimes contained both fragments and rounded pebbles, of the same or of different substances, imbedded in the finer mass

of the rock; pointing out a certain analogy to the secondary strata, and indicating the share which mechanical arrangements have taken in their formation. In the case of graywacké, the same structure is abundantly obvious, and in this instance it is equally extended to clay slate. I must now proceed to examine the red sandstone, as next in order of arrangement.

The general position and extent of this rock have already been sufficiently detailed, and it has also been seen that the principal tract occurs in the vicinity of Peel. At the southern extremity of this mass, the beds are elevated at an angle of forty-five degrees, dipping to the north. In proceeding from this point along the shore, they are found, after a short interval, to decline from this elevation, until at length they become nearly horizontal. As far as this point, no marks of disturbance are visible; but after again being elevated into a high position, and once more returning to the horizontal plane within a very short space, they become exceedingly irregular, and then suddenly terminate in the schist; the junction being perfectly visible. It is apparent, on considering the extent and form of the whole mass, that where the beds are most regular in their position, they are furthest removed from the schist, and that their irregularity becomes conspicuous only in proportion as they approximate to that rock. The actual junction is most easily examined within the high water mark, at the recess of the tide; where it is washed clean so as to be exposed to view with the same freshness it would exhibit on fracture; a very desirable circumstance, but not often to be found. Under the uncertainty already stated respecting the disposition of the schist, it is impossible to determine in what way the two rocks are disposed at the junction, as far as their relative stratifications are concerned; yet it may be remarked generally, that the fissile tendency of the schist is more or less opposed to the seams which separate

the beds of the sandstone. But a great change in the regularity of both, takes place at the points of contact between the two; the schist being much twisted and bent, and the regularity of the sandstone beds being nearly obliterated. Similar confusion occurs in the composition of the substances themselves; the schist becoming in some cases coarse, and charged with sand, and the sandstone being for a short space so intermingled with the argillaceous matter of the schist, as to put on the aspect and character of graywacké. These appearances however, extend on either side, only to a few feet; but it may also be remarked that the schist acquires a mixture of red in this place, while some parts of the sandstone, on the contrary, become blue.

The probable causes of this confusion of position and character, which not unfrequently occurs at the junctions of the primary and secondary rocks, have been subjects of discussion among geologists, but no satisfactory explanation of the appearances has yet been given. It may however be remarked that those causes which have been supposed to operate in producing similar effects, where the junction is that of granite or of trap with the stratified rocks, do not seem applicable to the present case; the junction here, being that of the primary with the secondary strata. These disturbances are also more interesting, since they are either of less frequent occurrence, or have been more rarely noticed. In most of the instances which have occurred in my experience in Scotland, such junctions are undisturbed and regular, the secondary rock lying on the primary, either in conformable order or otherwise. One conclusion however may perhaps be drawn from a consideration of the appearances in question. Whether the schist has acquired its present position, either in consequence of elevation or subsidence, it has not only been so disturbed after the deposition of the sandstone,

as the elevated position of this latter appears to demonstrate; but the causes which led to that change of position have been such as to extend their action, whether chemical, mechanical, or both united, through the primary to the secondary strata.

The mineral character of the sandstone now described, presents little variety. It is more commonly of a compact than a loose texture, and not unfrequently possesses the hardness and crystalline appearance of the primary sandstone, or of quartz rock. It is formed of sand intermixed with ferruginous clay, and is generally of a deep purple-brown. Occasionally it displays those white spherules so frequently occurring in the sandstones of this description, and already noticed in the account of Arran. The beds are often divided by seams of red or blue shale, or of clay, generally very thin; and they occasionally present that undulated surface which so accurately resembles the effect produced on hard sand during the retiring of the tide. Rare and thin beds of the coarser grit and breccia usually associated with this rock, are also to be seen, intermixed with the finer variety, and mica is not an unfrequent ingredient. The clay found in the seams has often the character of ironstone, and lumps of genuine red ironstone, apparently detached from some of the beds, are scattered on the shore in its vicinity. Two or three insignificant beds of white sandstone are also found alternating with it.

The last and most remarkable substance occurring in this sandstone, is magnesian limestone. This is highly crystalline, white, and of a pearly lustre, the scales, of which it is composed, being of considerable size and presenting curved surfaces. It forms flat masses of inconsiderable dimensions, which, being parallel to the stratification of the sandstone, might be considered as beds, but, as they frequently ramify into small filaments, they ought rather perhaps to be viewed as parallel veins.

Although the calcareous strata which are found at the southern side of the island following the red sandstone, are not here visible in the place where they might naturally be expected, it is probable that they exist in the neighbourhood, concealed by the sea which flows over them. This probability rests on the numerous fragments of a similar limestone which are thrown up in unexhausted succession on the western alluvial shore; often so little rounded as to render it probable that they have not been long detached from their native beds.

Such is the history of the principal tract of red sandstone occurring in this island. But there is another mass, mentioned in the topographical description, and noted in the map, which, however insignificant in dimension, is not so in a geological view; while, at the same time, it serves in some measure to connect the limestone and the schist, and to establish that order of succession from the primary to the secondary strata, which is most common, and to be esteemed most regular.

On examining the map it will be seen to occupy a small portion of the western side of Langness point. This rock is here classed with the red sandstone, rather from its geological position than its mineral character, since, strictly speaking, scarcely any real sandstone is to be observed. That substance occurs in one or two places only, seldom exceeding a few inches in thickness, and occupying a very small portion of the conglomerate beds of which it forms a part. But as the whole mass possesses a distinct analogy to that rock which is so often found occupying a more considerable extent, and separating the primary from the secondary rocks, there need be no hesitation in considering it as a portion of the lowest red sandstone, the remainder of which has possibly been removed by the usual causes of waste, of which this shore presents abundant indications.

The total dimension of the conglomerate is but trifling. Considered in its superficial dimensions, it forms a belt

on the shore of perhaps 300 or 400 feet in breadth, and scarcely a greater number of yards in length. Its breadth is greatest towards the south, where its junction with the schist is to be seen; the line occupied by the limestone, and that of the sandy bank which forms the shore, excluding it at length by their approximation.* The thickness of the collective beds is also inconsiderable, and might be computed, were it necessary, by a measurement of the exposed edges of the strata. The dip is to the north, at an angle of about fifteen degrees, being nearly in a reverse direction to that of the stratified rocks which lie above it at Castletown; whence it would appear that the strata are here disposed in a sort of concave or basin-like form.

The junction of this conglomerate with the schist may be traced in the high banks which form the shore, where it is indicated in the map. If the schist is here disposed in beds, and not merely in laminæ, at the high angle of eighty degrees, at which it appears to lie, the position of the conglomerate is unconformable to it; the dip of the schist being also here to the south, as that of the conglomerate is to the north, although neither of them are constant in this respect. The schist in this place is an ordinary fine clay slate, of a foliated texture.

The conglomerate is generally very coarse and loosely aggregated, containing larger and smaller fragments of quartz and schist cemented by clay and sand: thinner strata of a sandy clay also occur in it. In colour, it is either red or grey, and in some places is further mixed with calcareous matter and with fragments of limestone.

This conglomerate is immediately followed by the beds of limestone which are next to be described; some interference of the two, consisting of an occasional repetition of

* It is represented in the map as if crossing the isthmus at Langness point, but it is only clearly visible on the southern shore, where the beds are fairly exposed.

the conglomerate, taking place at the points where the change occurs.

It will hereafter be seen that the limestone beds in Derby haven which are continuous with these, come into contact with the primary strata without the intervention of the conglomerate. It is therefore apparent that the bed here described is of a very partial nature, and it may be conjectured to diminish in a wedge-like form till it disappears. It presents an example, analogous to those cases occurring in Sky and elsewhere, of the extenuation and disappearance of the lowest secondary strata, and of the consequent contact of a superior set with the primary rocks.

It is now necessary to proceed to the examination of the limestone, being the uppermost of the stratified rocks found in the island.* Its general extent is already understood, from the topographical description which has preceded, and from the accompanying map. However different in mineral character the stratified and the unstratified limestone may seem to be, there will be sufficient proof in the course of this examination that they are only different parts of one common deposit. At the same time this examination will throw light on many obscure points in the history of the unstratified limestones.

By far the greater portion of this limestone is disposed in thin beds, in a parallel manner. The thickness of these

* It is here proper to remark that many beds of breccia are found connected with this calcareous deposit, and occasionally, superior in position. But these are of a partial nature, and are no where of such extent or importance as to interfere with the claims of the limestone to the rank here assigned to it. In other respects the perpetual interference of the different breccias with the limestone, renders it impossible to describe the latter without occasionally adverting to these. It will hereafter be necessary, even at the risk of some repetition, to collect the whole of them into one general view.

varies every where; rarely exceeding two feet, and seldom descending to three or four inches. In consequence of the general flatness of their position, and that of the shore, large portions are in many places completely exposed by the recess of the tide; and, being thus also perpetually washed, they admit of being examined in the fullest manner. In many places indeed, access may be had to the edges of the beds, from the surfaces even down to the schist. This is more particularly the case between Derby haven and Langness peninsula; the lowest points of the limestone being visible in contact with the schist near the Santon river on one side, and with the conglomerate near Langness point on the other; while the uppermost beds are exposed in many intermediate points, if these can be determined, as they appear to be, by a particular breccia hereafter to be described, which covers them. The thickness of the collective mass is necessarily greatest at some of these intermediate points, and diminishes in approaching the schist on the one hand and the breccia on the other. That thickness, were it an object of any moment, might be estimated by carefully tracing the exposed edges of the beds. In some attempts at boring which were once instituted in pursuit of coal, forty-five or forty-six fathoms were passed through without reaching the fundamental rock.

Although the general position of the limestone beds is flat, it is rarely quite horizontal. Such a disposition however occurs in two or three places, where, in consequence of a slow and gentle undulation of the strata, the tendency of the dip becomes reversed. In these cases a variation of the angle of inclination takes place, amounting to ten degrees or more, and the tendency of the dip necessarily varies: at Santon river it is south, near Port la Marie east-south-east, while in other places it respects other points of the compass.

In a few places, the inclination of the limestone is much greater than that above mentioned, and these cases occur

either in the immediate neighbourhood of the fundamental rock, or in that of the trap veins. They are attended with marked curvatures of the beds, and will be described in examining the general connexions of the different rocks hereafter.

The beds of limestone are found to alternate with breccias of different characters, above noticed; but these are, generally speaking, either at the bottom or at the top of the limestone mass.

Besides these breccias, beds of shale, or of clay, more or less approaching to that substance by its induration, are found interposed among the limestone beds. This is far too common an appearance to require any further notice.

The colour of the stratified limestone varies slightly in different places, but is generally limited to different shades of dark and blueish grey; the darkest, which approaches near to pure black, being the marble of Pool vash formerly described.

The differences in composition lie also within narrow limits, and consist in the greater or less predominance of argillaceous earth, as well as of silica, in the calcareous rock.

Magnesia is also occasionally found as an ingredient, but it is unnecessary to dwell on circumstances of so ordinary a nature, as similar limestones are familiar to geologists.

It is equally superfluous to detail the texture, fracture, and general appearances of this rock, which vary from smooth and conchoidal, to granular or earthy, as in other instances of almost daily occurrence.

The organic remains are abundantly dispersed through almost every part of the calcareous strata, and of the interposed shales; being however much more numerous and entire in some places than in others. Occasionally they are absent altogether, but they are rarely wanting for any considerable space. Their cavities are in almost

every instance filled with calcareous matter, to which rule one very remarkable exception is found. This occurs in the black beds from which the marble formerly described is procured. Here, the animal remains are all converted into pyrites, while at the same time their forms are more destroyed than in those situations where they are calcareous. It is uncertain whether the vicinity of a considerable trap vein, which traverses the limestone at this place, may have had any influence in producing this change.*

The unstratified limestone, which accompanies the regular beds, is found irregularly interspersed in detached masses throughout the whole calcareous tract, of which it forms a part. It is neither placed above, nor, as might more naturally be expected, below the strata, but is irre-

* The following list contains a general catalogue of the organic remains which I observed in this rock :—

Pecten—three species, but neither of them so perfect as to admit of being determined.

Madreporitæ—turbinated; conical; ramose with small, and ramose with large stars.

Orthoceratitæ.

Trochitæ—small and large.

Ammonitæ—the species undescribed? The shell is smooth, the back flat; the sides longitudinally sulcated, one groove running near the outer edge, and the other, a third larger, running nearly on the middle, but rather towards the outer than the inner edge.

Corallinitæ—ramose, flustriform, and straight filiform, resembling those found in the limestone of Dudley.

Productus.—A species of this genus as formed by Sowerby, but not definable. It resembles somewhat the Conchyliolithus (anomites) scabriculus of Martin.

Another species, remarkable for the fineness of the striæ.

A turbinated shell, the mouth of which being broken, the genus cannot be ascertained; but the form of the wreath, and the clavellæ disposed on the upper part of the whirls, and passing off into fine plicæ, give it a resemblance to the genus Cerithium.

Another turbinated shell, equally obscure.

Several unassignable bivalves; besides other fragments so obscure as not to admit even of a conjecture respecting them.

gularly intermixed with them, forming a portion of the common deposit. Although it is here called unstratified, on account of its predominant character, this feature is not always definite; since it is found in certain places to pass gradually from a shapeless mass into the form of regular beds, and, in certain cases, may even be traced into the ordinary stratified rock.

It is commonly of a crystalline texture, often indeed highly so, like some varieties of the primary limestones; the plates being of large size, and at times translucent on the edges of the fracture. It is extremely refractory under the hammer, and all these distinguishing characteristics are most perfect where the semblance of stratification is most completely wanting. Where it passes into the stratified limestone, its mineral character also undergoes a gradual alteration, until it ceases to be distinguishable from that variety.

In colour, it displays nearly the same modifications as the stratified limestone, with the exception of black, of which no instance occurred during the investigation. The paler greys seem to predominate, and in some partial spots the rock even becomes of an impure white. This circumstance is interesting, and is analogous to that pointed out in Sky. If the unstratified is a portion of the stratified rock, changed in character by some operations posterior to its deposition, it would hence appear that the causes, whatever they may have been, have also dissipated the bituminous matter from which the colour is derived; as they also seem to have destroyed the organization of the shells once imbedded in it. A breccia consisting solely of different coloured fragments of the same variety, and entirely different from those formerly mentioned, is found connected with it near the contact with the schist in the neighbourhood of the Santon river.

The unstratified limestone is often so changed, and that to so great a depth from the surface, that its true

character can only be discovered after a deep fracture. In these cases it becomes yellow and dark brown; thus assuming, in some instances, the aspect of the yellow magnesian limestone of England.

Brown spar is occasionally found in the rifts, and also in nests occupying irregular cavities. It must however be remarked that the same mineral exists generally in the rifts also of the stratified limestone, being in both cases crystallized in its most ordinary form; the only difference being, that in the latter case it is white with the usual pearly lustre, while, in the unstratified rock, it is brown, and may often with equal propriety be termed calcareous iron ore.

In general, no shells or organic remains are to be found in the unstratified rock; but as some of the exceptions are important, it is necessary to be more particular in tracing them.

Near the Santon river, at the junction of the schist, and where one of the most conspicuous and interesting of these masses is to be seen, no shells occur for a considerable space. But as the unstratified rock approaches to the stratified, it undergoes a gradual alteration, the crystalline texture gradually passing into the earthy, and the change being complete when the beds have put on that which may be called their natural form. The organic remains increase in the same proportion, being sparingly found at first and in the intermediate parts of the change, and becoming abundant when that is complete, as they were absent before its commencement. In one place only they were found imbedded in the crystalline limestone, but in this place their forms were less accurately preserved than usual; a remark which was confirmed in other instances where they were found in a similar situation. It is important to note, that in these instances the organic substances are similar to those found in the stratified limestone; and they prove the original identity of the cal-

careous deposit under both its present forms, even in those cases where the actual gradation between the beds and the shapeless rock cannot be traced.

The next, and by much the most decided examples of the absence of organic remains in the unstratified rock, are to be seen in the neighbourhood of the black strata at Pool vash. Both kinds of limestone are here found together, the irregular being predominant; but they are so situated that it is impossible to trace any connexion between them beyond that of juxtaposition; a circumstance which is probably to be attributed to the form of the shore, which is flat, and to the imperfect manner in which the beds are exposed. Had no other portions than these been visible, the nature of the important connexion between the two, might still have remained unknown. It must be remarked that although the irregular rock possesses here no marks whatever of stratification, it cannot be called crystalline, except in a few points. A perfect idea of it may be given to those who have visited Devonshire, by saying that it resembles the limestone near Stonehouse; and perhaps an idea of the crystalline variety more accurate than can be formed from the preceding description, may also be conveyed by comparing it to that which is seen near the same place at the Devil's point. Other analogies will be apparent hereafter.

In the rock thus described, the organic remains abound, as they do in that which is stratified, but their forms are neither so entire nor so decided. It is not however certain that in this instance, as in the former, they have themselves undergone any change, since their obscurity may arise from the difficulty of procuring specimens of the rock, as fair and as perfect as those which can be obtained from the regular limestone.

It is unnecessary to quote any more of the places where similar appearances occur, as they offer no material dif-

ferences, and the present object is rather to select the most important circumstances, than to enter into a detail of every minute particular which was examined.

But before quitting this part of the subject, it is proper to point out the very remarkable forms which the unstratified limestone assumes on weathering; by which, together with its superior durability, it is in all cases readily distinguished, even at a distance, from the stratified. In almost every instance, its superior hardness, and the greater resistance it offers to the sea and weather, cause it to project in rough masses, often many feet in height, above the surrounding stratified rock. It presents in these, as in most other cases, an angular large fracture; consisting of an aggregation of small irregular pyramidal bodies with intervening cavities; not the least semblance even of displaced stratification being visible. In some instances it decomposes by weathering, into round honeycombed cavities separated by irregular ridges; resembling that limestone which occurs at Broadford and at Kilbride in Sky. Its resemblance to that rock in other circumstances, will be apparent from the whole of its history, and each serves mutually to illustrate the other.

In attempting to determine whether or not the limestone of this island is conformable to the schist on which it lies, it becomes immediately obvious that it must occur in both ways, namely, parallel to some of the strata of that rock, and at angles to others; since, in a general view, it is placed at a common low angle, while the schist occupies every intervening one from the horizontal to the vertical line. Under the circumstances of obscurity formerly stated, respecting the real position of the schistose beds, and the difficulty of distinguishing them from the laminæ, it would be impossible to determine this point more accurately; since they may often appear conformable where they are reversed, and the contrary.

It would be superfluous to trace all the points where the actual junction of the schist and limestone can be

observed, or their probable meeting inferred. The geological conclusions which may be drawn from these facts, will be equally deducible from one or two selected examples.

This junction is displayed in great perfection near the mouth of the Santon river, where the boundary of the limestone, towards the east, is marked on the map. The position of the schist is here very irregular, but the laminæ are placed at high angles, varying from forty-five degrees to the perpendicular.

Although here of the usual blue colour and ordinary degree of hardness which it displays elsewhere in the vicinity, it is red and decomposed at the immediate line of junction; and the same appearance may also be observed in the limestone for a similar space; while in neither does it extend beyond a few feet. The appearance exactly resembles that already described as occurring at the junction of the red sandstone near Peel.

The limestone is here seen under both its forms, the stratified and the unstratified, but the former is modified in a manner which requires further explanation. In one part of the junction, the schist and the irregular limestone are in immediate contact, the character of the latter corresponding so exactly with the general account already given, as to require no further notice. But where the stratified rock abuts against the schist, it is suddenly diverted from the low position in which it is found at a small distance; being turned upwards in a curved form till it acquires a position considerably erect.* At the same time, there takes place a gradual change in that accurate parallelism and evenness of the beds which were before predominant. They become rough, undulated, unequal in thickness, and deficient in that apparently nice adaptation to each other which they possess where in their natural or stratified position. In the same circum-

* Plate XXVII. fig. 1.

stances, their mode of weathering is altered, from the former flaky and even, to the irregular cavernous and pyramidal manner by which the unstratified rock is distinguished. Their composition and general characters undergo corresponding changes. As already remarked, the organic substances gradually disappear, and the earthy aspect gradually also becomes converted into the crystalline, so that the stratified and the unstratified rocks cease at length to possess any mineralogical distinction.

It is further necessary to observe, that these changes occur in two distinct modes. The first may be traced by following the progress of each individual stratum from a point near the schist to one at a distance from it, and is seen in those cases where the edges of the strata come into contact with the fundamental rock.* The next occurs where the unstratified rock lies between the schist and the stratified one, and takes place, according to the order of succession in the strata, in the following manner.† By degrees the irregular appearance of the unstratified mass diminishes, and it is then succeeded by an irregular bed having a rude conformity to those of more regular form which are to follow. The succeeding strata become gradually more even, and more resembling the ordinary stratified and prevailing limestone, till a perfect uniformity at length takes place. A complete transition may therefore be traced, in this direction also, from the unstratified to the stratified rock; and that transition is accompanied by the same circumstances with regard to the mode of weathering, the appearance and number of the organic remains, and the texture, as have just been pointed out in the other case.

This account of the junctions, and of the transitions of the two limestones, must not however be concluded without mentioning, that other marks of change, and indi-

* Plate XXVII. fig. 1. † Plate XXVII. fig. 2.

cations of violence, are impressed on the unstratified rock. In the stratified one, the usual appearance of straight joints, filled with ordinary or magnesian carbonate of lime, occurs, but in no great abundance. The unstratified is, on the contrary, penetrated by innumerable fissures crossing each other in irregular directions, and filled with the same materials. Here also, at the entrance of the Santon river, is to be seen the breccia which was formerly mentioned. This is a part of one of the irregular beds, and it consists of fragments of the crystalline rock, cemented by the same substances which fill the rifts of the limestone in other places; as if in this particular spot the rock had been broken into fragments, instead of yielding in a body to the impression of the disturbing force.

After thus minutely detailing the changes apparent at this junction, it is proper to say that, in many other instances, it is impossible to trace any passage from the crystalline rock to the ordinary one, nor from the unstratified to the stratified disposition; but that the change is sudden and perfectly defined; while, at the same time, the proximity of the schist cannot be detected.

There is yet another distinct set of appearances, connected with the change from the stratified to the unstratified limestone. There are two examples of this, each of which is sufficiently distinguished from the other to require a separate detail.

Near Scarlet point, the successive beds of stratified limestone are to be traced in a flat position; following each other in a very even and regular manner for a considerable space. On a sudden they undergo an undulation in repeated curves, and are then intersected by a number of trap veins.* These veins are repeated at intervals for some distance along this shore in proceeding westward. They all lie in a position more or less erect, and their general tendency is towards the south-west; but as they

* Plate XXVII. fig. 3.

are not parallel to each other, their direction cannot be more accurately assigned. They ramify at times, in a manner which appears somewhat complicated, many of the branches being very minute. Two or three are more remarkable than the rest, but it is unnecessary to describe either their dimensions or numbers very particularly.

Where they first appear to the eastward, the stratified limestone terminates abruptly, and is succeeded by a very conspicuous mass of the unstratified rock. The same rock, under circumstances of much confusion, is continued throughout the greater part of the space intersected by these veins; that confusion being much increased, and considerable difficulty thrown in the way of the examination, by the occurrence of a breccia, which, wherever the limestone is undisturbed, is found in a position superior to it, but is here irregularly intermixed and confounded with the calcareous mass. Hence it is difficult to determine whether the unstratified limestone and the trap veins are every where co-existent; but whether they are or not in this particular instance, is of no moment, since, in the next example, the latter are found traversing a stratified limestone. The immediate junctions of the veins and the limestone, do not any where appear to be attended with circumstances in the texture of either, sufficiently remarkable to require particular notice. Such changes as are apparent, resemble those now so often described as to have ceased to be objects of curiosity.

Although the stratified limestone recurs beyond Scarlet point, it never again becomes as regular as before, but continues undulated, distorted, and broken by deep gullies, as far as Pool vash. Along this shore it is covered by the same breccia, consisting of fragments of schist and clay intermixed; by which its real position is much obscured.

A considerable trap vein is found near the black marble quarry at Pool vash, forming the third and last example of this junction which it appears necessary to describe.

In this case the passage of the vein is not connected with any change from the stratified to the unstratified limestone; since the former is found lying on both sides of it. At some little distance from this vein it however ceases, and is replaced by the unstratified, which prevails along the remainder of the shore towards Kintracht, where it terminates.

The works of the quarry have laid open the junction of the black strata and the trap. They are here found firmly united; a disturbance also taking place in the beds, but extending to a distance of two or three feet only from the planes of contact.

A more remarkable change is visible where the superincumbent breccia and the limestone meet, and this change, as far as I could trace it, seems limited to the neighbourhood of the trap. In other places the breccia seems evenly disposed on the plain surface of the limestone; but here, the latter is elevated into ridges, undulations, and acute points, the former adapting itself to them. In different places also, fragments of the limestone are entangled in the breccia, and processes resembling short veins rise from it and traverse that rock. All these circumstances seem to bespeak some disturbance since the breccia and limestone were deposited. The pseudomorphous veins are similar in their characters to those formerly noticed in treating of Isla, and are doubtless to be attributed to analogous causes. It is unnecessary to make any further remarks on the phenomena attending the passage of the veins, excepting as far as the unstratified limestone is concerned; since nothing new can be added on a subject concerning which so much has already been said throughout this work.

In reviewing the whole of the preceding facts which relate to the stratified and unstratified limestone, the following conclusions seem to be among the most interesting.

The whole limestone mass, whether stratified or unstra-

tified, consists of one deposit, or of one series, as is proved by its continuity, and by the identity of the organic remains. The absence of the stratified disposition is therefore no proof that any given limestone does not belong to the class of the secondary rocks, a conclusion equally deducible from the history of the calcareous district of Sky. There is consequently no reason *a priori* why a limestone of even much more recent formation than this should not be found unstratified.

The absence of organic remains proves nothing respecting the comparative antiquity of limestone, and the crystalline texture is also an imperfect criterion of the geological relations of any given mass of that substance; deductions which are equally to be made from the same example.

There appears no definable limit of the extent to which a limestone, really secondary, may exist in an unstratified state; and the various unstratified limestones which have been described in different parts of the world, as of a period prior to the secondary rocks, require therefore to be re-examined; excepting those which alternate with gneiss, micaceous schist, quartz rock, or argillaceous schist.

Some of these conclusions will, in a practical view, be equally valuable, whether the limestone be supposed to have been originally formed in the mixed manner in which it now appears, or to have undergone the change from the stratified disposition to the unstratified, in consequence of posterior alterations.

It is now necessary to remark that the confusion of structure here described, appears hitherto to be limited to limestone, a circumstance which may suggest the explanation that has already been indicated by the corresponding facts formerly stated, namely, that it is the result of the fusible nature of that rock. Nor is it possible to avoid remarking the analogy which exists between this case, and those formerly noticed, where masses of trap are to be found intimately associated with schistose rocks, as in the hill of Kinnoul, and entangling fragments which

bear the marks of partial fusion. Considering the different qualities of the respective substances, there is a perfect correspondence between the changes in both cases. There is however one important circumstance present in Sky, which is here wanting, at least throughout the greater part of the space where the unstratified limestone occurs. The existence of overlying syenite in that island, was there supposed to offer a solution of the phenomena in question; as the passage of trap veins has been shown, in other instances, to produce analogous effects. Although the veins of Scarlet point may be supposed to have caused the irregularity and change of structure there apparent in the limestone, no such veins exist throughout the greater part of the space where the unstratified limestone occurs. Nor is even granite here visible; the calcareous rock being in contact with the argillaceous schist wherever it admits of examination. No apparent and analogous cause therefore exists in the Isle of Man, for that change in the nature of the limestone, which, in Sky, is supposed to have been the consequence of the presence of syenite. Yet there are circumstances, in the characters both of the sandstone and the schist, which seem to indicate that they have also undergone some analogous changes; differing, it is true, but these differences depending on the relative nature of the different substances.

It will be remembered that, in the vicinity of the schist, the sandstone of Peel possesses an unusually indurated texture; and that the two rocks are fractured and intermixed at the junction, while the characters of both are changed. In other places, the schist presents similar marks of some posterior influence, by which it has been fractured where in contact with the secondary strata, and its iron oxydated to redness. It is easy to imagine that such effects might, in these two rocks, be produced by the same causes which were capable of destroying the original forms and characters of the stratified limestone.

Thus the arguments must remain; as in attempting to

assign causes for the changes in this place, of a nature similar to those which have been supposed to have acted in Sky, it can only be conjectured that the granite of the Isle of Man exists beneath these strata, at a distance sufficiently small to have produced the effects in question.

It is enough to have suggested this hypothetical explanation of an obscure and very interesting circumstance; but before entirely dismissing the subject, it will not be useless to inquire how far the history of this limestone can be applied to the illustration of other instances where the same or similar obscurities exist. Of these I am practically acquainted with two only; the case occurring in Sky, already sufficiently considered, and that of Plymouth.

The difficulty which occurs in respect to the characters and connexions of the unstratified limestone of Plymouth, arises, probably, in a great degree, from an insufficient acquaintance with it. In its disposition and general characters, it strongly resembles the examples here described, and, like the whole of the limestone of the Isle of Man, it follows an argillaceous schist which is incumbent on granite. It is probable that a closer investigation of its connexions may hereafter enable us to draw the comparison still nearer, and to ascertain its resemblance in the more important particulars still wanting to complete its history.

This suggestion will not be fruitless, if it shall stimulate those who may have an opportunity, to trace it with the care and perseverance which it merits and requires. To those who are inclined to undertake this pursuit, I may point out the propriety of endeavouring in the first place to trace its contact with the fundamental rocks; secondly, of searching for the stratified limestones which may exist in the same district, and of comparing the organic remains contained in each; and lastly, of attempting to determine, at some intermediate points between the two, whether the real transition of the unstratified into the stratified rock cannot here also be found.

The obscurity which attends the different breccias that accompany the limestone, renders it expedient to reserve a separate paragraph for their description.

No continuous beds of either of them can be traced; since even that one, of which the greatest extent is visible, is much interrupted and confused, either in consequence of the trap veins or from other causes. With respect to the others, they are only to be seen occasionally, where their inclined position causes their edges to appear on different parts of the shore, or where they are detected by some casual fracture of the ground. There is consequently much difficulty in discovering their relations to the limestone, which can only be deduced from careful comparisons of their internal characters and positions together, at the several interrupted points where they appear. They seem to admit of being divided into two classes, those which are found below the limestone, and those which lie above it.

In describing the sandstone at Peel and at Langness, it was shown, that although the schist and the limestone are in some places separated by the conglomerate, in others, the contact of these two substances is immediate.

In these cases no breccia intervenes, but a sort of approximation to one may be occasionally seen in the numerous fractures of the limestone, afterwards filled up by calcareous spar. In one instance, already pointed out, this fracture becomes so complete, and the fragments are separated by intervals so wide and so irregular, that a perfect breccia is the result.

Another similar substance, apparently intermediate, both in position and structure, between the limestone and the schist, is found at Derby haven, and in other situations which it is unnecessary to detail. The basis of this is calcareous, and it contains irregular fragments of schist and quartz. Its analogy, both in position and in origin, to the breccia of the red sandstone is obvious; and it may be conceived to be the evanescent edge of that rock. It

is perhaps easily explained by examining existing alluvia, which are found commencing by a thin edge, and gradually increasing in depth as circumstances favour their accumulation. If it be supposed that calcareous matter was deposited on such a compound surface, capable of forming a solid rock, it is evident that at a point above the alluvia it would be immediately united to the fixed and original rock, while these would be converted by its infiltration in some places, into a breccia of the present structure; the remainder forming, by the unknown processes of induration, a bed of ordinary conglomerate. Thus the wedge-like form and partial extent of similar rocks are also explained.

The last breccia which I observed as inferior in position to the limestone, is remarkable for its structure. It is visible near the Abbey at Balla salla, where its position however can only be conjectured. At Port la Marie, it is actually visible beneath the limestone. It consists of rounded grains and pebbles of white quartz cemented by limestone, and undergoes a slight alternation with, and gradation into that rock, before it finally disappears. It is of inconsiderable thickness, and its analogy to those already described, in origin and nature, need not be more particularly pointed out.

Such are the varieties of conglomerated rock inferior in position to the limestone. It is possible that there may be others still unnoticed, but there will be no difficulty in classing them, if attention is paid to their structure. When they consist of fragments of the fundamental rock, whether rounded or angular, cemented by a calcareous base, or indurated without that cement, it is probable that they are all inferior to the limestone; and whenever they contain fragments of the limestone itself, it is equally probable that they have been formed by subsequent changes, after a certain portion or the whole of the calcareous beds had been deposited. In the latter of these cases, they will be

found alternating with some of the upper beds, or superior in position to the whole of them.

Of such beds, posterior to the calcareous deposit, I only remarked two. One of these is visible at Derby haven, and also in the neighbourhood of Pool vash. It consists of fragments of schist, quartz, and limestone, united by a calcareous base, and is of a coarse texture. It does not seem to extend far beyond the boundary of the schist, and the explanation of its origin cannot be attended with much difficulty. The fragments of limestone serve to distinguish it from those already enumerated, even where its true position cannot be discovered.

The other is far more obscure, while it is perfectly dissimilar from all the rest, and indeed from any rock of this description with which I am acquainted. It consists of minute fragments of schist cemented by a basis of clay, but varies slightly in different places. The fragments are sometimes conspicuous, and, at others, the whole is reduced to a scaly powder. In certain cases it also contains fragments of limestone, as well as of quartz, and the argillaceous base is occasionally more or less calcareous.

It is found extending interruptedly from Scarlet point to Pool vash, being almost every where visible at the surface of the limestone, but alternating also with some of its beds. The confusion, which prevents it from being easily understood, arises partly from the action of the sea in an unequal manner on a substance so tender, but still more from the general irregularity of the calcareous substratum where the trap veins are found, and from the apparent disturbance produced at the places of their intersections.

Although it is not easy to explain in a satisfactory manner the formation of this rock, I may still point out the resemblance which it bears in its materials to the rubbish and clay which result from the action of the atmosphere on the present exposed surfaces of the schist, and

which are found accumulated in beds in almost every part of the island. It is not difficult to imagine that such substances were deposited during the progress, or after the termination of the calcareous formation, and that they were distributed over the surface of the beds and indurated into their present condition, before the sea had quitted the rocks, or these had emerged from the waters.

I must now proceed to the last of the rocks, namely, the trap veins; the particular description of which was reserved to this place, to avoid interrupting the more interesting parts of their general history.

The places of those which were observed, have already been pointed out in speaking of the limestone. The general connexion of these with the stratified rock, and the influence, apparent or real, which they may have possessed over its character and disposition, have already been sufficiently described. It only remains to notice the individual specimens in greater detail than could then have been conveniently adopted.

Some of the smaller, which occur near Scarlet point and at Pool vash, are composed of an ordinary fine greenstone, which in certain places becoming perfectly compact, smooth, and uniform, may perhaps be considered as a basalt. These basaltic specimens are, in general, of a dark lead blue, but I observed one vein not exceeding an inch in breadth, of a glossy black, nearly resembling in lustre and compactness the basis of the well-known porphyry of Egg. It traverses a smooth conchoidal limestone, with which it is firmly united at the edges.

The principal veins near Scarlet point present a porphyritic texture. The basis is here of a pale or dark grey, and the crystals of felspar are of the same colour, being very conspicuous, and possessing the common as well as the glassy lustre. In some places these veins are decomposed; or rather, they have undergone the change which precedes decomposition, to such a depth, as to put on the deceptive appearance of a common yellow felspar por-

phyry; the fallacy being only detected by penetrating to a considerable depth in the stone. This case is parallel to those formerly noticed in treating of the Slate isles.

Some of the veins also possess the amygdaloidal character, the compact greenstone basis being filled with rounded grains, which, as far as I observed them, seemed always to consist of calcareous carbonate; and in certain cases the porphyritic and amygdaloidal characters are combined in the same rock.

At Pool vash, the trap veins are of an earthy character and very pale grey colour, not much unlike some of the tufaceous rocks which so often accompany the great deposits of trap. Even in these cases, certain parts of the vein assume the more ordinary character of greenstone. All these are very firmly united to the limestone which they traverse, and contain grains of pyrites interspersed throughout. In many places, they possess a foliated or schistose structure, which is detected by the progress of decomposition; the whole exfoliating in thin earthy laminæ, the direction of which is always parallel to the side of the vein.

The last variety which remains to be described, is remarkable for containing olivin dispersed in considerable abundance throughout it, in small grains, and of a yellow colour. This variety is also schistose, and is found at Scarlet point.

Before closing the account of the rocks of this island, it is necessary to point out one substance, which, although it may be viewed as incidental, is nevertheless interesting; since it serves to throw light on the composition of certain mineral veins which have been the subjects of discussion, and may also perhaps explain an appearance occurring in Lewis, which was noticed in the account of that island.

Near the point where the schist and sandstone unite, in the neighbourhood of Peel, a conglomerate of rolled pebbles is seen adhering to the face of the schist, which

is here vertical and even. At first sight the appearance is somewhat extraordinary, since it looks like the exposed surface of a bed in a vertical position, placed in the midst of the schist, and unconnected with the sandstones in its vicinity. On a more careful examination, the deception is explained by discovering that a fissure has formerly existed in this place, and that in consequence of the fall of the rock which formed one side of it, the opposite and remaining wall has been exposed to view. This wall is covered by the conglomerate in question, which has apparently been formed while the fissure was still entire and empty, by the falling down into it from above, of such loose materials, consisting of rolled and other fragments, as were in the vicinity, and by the subsequent infiltration of calcareous and ferruginous carbonates, of which the marks are in other places apparent on the surface of the schist. It is in fact a conglomerate vein. It is impossible to form any conjectures respecting its antiquity; nor to discover, from any thing visible, whether, like the empty fissures mentioned near Spanish head, it is of recent origin, or whether it may be ranked in point of age with the mineral veins of this island or of other countries. It is certainly of no moment as far as respects the general theory of metallic veins; but, whether recent or ancient, it serves to illustrate in some degree the origin of those veins, which, like the well known example at the Relistian mine in Cornwall, contain rounded conglomerates.

As in most other places, great anxiety is manifested in the Isle of Man for the discovery of coal. It is not however easy to understand the value of the discovery, even were it made, when the trifling expense of freight from Whitehaven, and the facility of delivering a cargo on so many points of this extended coast, would cause the produce of those mines to rival it in a competition, almost in every instance where land carriage was concerned. It is asserted that coal has been found in the red sandstone near Peel; but there is little reason to doubt that the frag-

ments in question had either been washed ashore by the sea, vessels laden with this article having been lost on the coast, or that they have been the consequences of fraudulent views on the part of interested coal surveyors or miners. Since my visit to the island I have however received fragments of coal, which appear, on good authority, to have been found under the limestone or in the conglomerate of Derby haven, where some expensive borings for that purpose were formerly made. The specimens are of a dry and splendent quality, resembling the coal of Arran, and they are, very probably, analogous to it in situation. They do not appear to offer any temptation in an economical view, even abstracting the commercial objection just stated.

METALLIFEROUS veins are found in different parts of this island. They vary much in importance in the several places where they occur; and the smaller, which have been observed at different times, have, as might be expected, fallen into such oblivion, that it is scarcely possible to procure accurate information about their situations. A few of these are still remembered by the old miners who were formerly employed in the works that were carried on in the larger veins; and among them two or three were pointed out to me in Port Eirin. It is unnecessary to take further notice of them than merely to say that they contain the same substances as the larger veins, and that they lie in the same direction. This direction is, in all the veins, from north to south, or nearly so; the variations among them not exceeding two points. They are all nearly erect, and contain the same substances disposed in a similar manner.

The three principal veins which have been wrought, are at Laxey, Brada head, and Foxdale: some workings have also been carried on at Balla corkish, and at Glen

sash, near Port la Marie. It is now some time since they were abandoned, nor is there at present any prospect of their renewal. The information with respect to them which is now to be procured from actual examination, is therefore very scanty; the more so, that the remains of the workings at some of them, are scarcely in an accessible state. A description of the structure of the Laxey vein, will almost supersede the necessity of entering into details respecting the others.

This vein comes to light at a short distance from the town of Laxey, in a small and narrow glen which affords passage to a mountain stream. It has been wrought by a drift opened on the course of the vein itself, with an air-shaft from the surface. Another opening upon its course lower down the stream, is now filled up with rubbish, and therefore inaccessible. The course of the vein is N. N. E. and it varies near its entrance, from two to six feet in breadth, dipping towards the east in an angle which appears to amount to five or six degrees. In the miner's report it is stated at sixteen or eighteen. The vein lies in the ordinary clay slate already described, which in this place is generally of a smooth texture and silky lustre; but varieties of the finer graywacké composition, and of the quartzose and granular kinds, are also found in the immediate vicinity mixed with it.

Fragments of all these substances, of different sizes, united into a breccia by an imperfectly crystallized quartz, form the vein stone. In the cavities, the quartz is sometimes crystallized, and the same happens in the other veins, at Brada head and at Foxdale; from the latter of which very splendid specimens have been obtained. In all these places the quartz crystal presents the same forms, namely, that of a short prism terminated by a pyramid at each end, and consequently attached by its side, or else that of the pyramidal termination only.

The metallic substances, consisting of lead, zinc, copper, and iron, are irregularly dispersed and mixed with the

vein stone. Both the lead and copper have been wrought. The lead is found in the form of ordinary galena, mixed with the steel grained variety, and has therefore, when the latter has appeared sufficiently abundant, been subjected to the process of cupellation. Carbonate of lead has been said to have occurred with it, but I saw no specimens of that substance: the galena is never crystallized.

The copper is in the form of the yellow sulphuret, and, like the lead, was always found massive. It does not appear to have been attended by any other ore; the carbonate of copper now found among the workings being the result of the present action of the air and the rains.

The blende, which is the only ore of zinc, is brown, and is frequently crystallized; but in so confused a manner as not to permit the modifications to be ascertained. It is in considerable abundance, and is attended by some insignificant lumps of compact calamine.

Iron appears only in the shape of calcareous ore, and is either massive, or crystallized in its most common form, namely, a part of the primitive rhomb with curved surfaces. Its nature was unknown to the miners, and consequently no attempt was made to apply it to use. It is here, as in the other veins, abundant.

The vein at Brada head is supposed to have been formerly wrought by the Scandinavian possessors of this island. The more recent workings have been now abandoned for about twenty years.

This vein lies due north, and, after intersecting the high promontory in which it is found, grazes the cliffs of one still further to the north; appearing also in the high land on the southern side of Port Eirin. It has been wrought at all the former points, by driving directly on the body of the vein, but the principal working has been on the northern boundary of this small bay. The position of the vein is erect, and appears, like that at

Laxey, nearly vertical, as far as any judgment can be formed from above. Its breadth is irregular, and where I measured it, varies from six to nine feet.

The circumstances which attend the Brada vein, are in every respect so like those at Laxey, that it would be superfluous to describe them: I need only add that the greatest proportion of copper was found near its southern end, and that of lead near its northern one. The quartz crystals are also here occasionally encrusted by a deposit of chalcedony.

The history of the mine at Foxdale appears so precisely similar to those already described, with the exception of the granite formerly mentioned, that it is equally superfluous to dwell on it. The direction, dip, and composition of this vein, were in every respect the same. The only circumstance in which it differed, namely, the presence of the granite, is now incapable of being examined, from the demolished state of the workings.

It is also unnecessary to notice the two other veins which were mentioned. Neither of them was very productive, and as far as the reports of the miners go, they bore a precise resemblance to the rest.

Having thus detailed the little information which I was able to procure, either from personal observation, or recorded history, relating to the mines of this island, it only remains to enumerate the independent mineral substances which are found in it, having already described those which are evidently of foreign origin, in the account of the alluvia of the country and of the sea shore.

Quartz, as it is the most conspicuous of these, so it is the most various in aspect. It is found scattered, often in very large blocks, over every part of the surface. Its origin is easily traced to the schist, in which it is also frequently seen, forming detached irregular nodules or veins, of greater or less extent and intricacy. It is most generally of a pure white, with a lustre approaching to the oily; sometimes, of a grey and dirty hue. Occasionally it is found of a dove colour, and all these

specimens assume at times a certain degree of transparency. In the vicinity of Laxey I observed fragments of white quartz stained irregularly with black; the black matter appearing to be uncrystallized tourmalin, since crystals of this mineral were found shooting from it through the quartz.

In several places chlorite was found imbedded in small cavities in the quartz, and, as is very common, entangled in its substance.

Talc also occurs in the quartz in several situations. It is generally found in small scales, or in a more continuous form, in the rifts of that substance. In the metallic vein of Laxey it may also be seen in larger concretions, consisting of minute particles aggregated in pulverulent or scaly lumps, and of a pearly brilliancy.

Mica is occasionally found in the quartz in similar circumstances, being readily distinguishable from the talc by the well known characters of both. A less common variety of this mineral, of a bright gold colour and of a highly metallic lustre, occurs also in the clay slate, a rock with which it is rarely associated in a form so conspicuous. It forms irregular lumps of no great size, imbedded in the schist, and consisting of distinct plates confusedly entangled together.

A few metallic substances, independent of those enumerated in the description of the mines, have been found in the island, but two of them have not been traced to their native places.

Wolfram is the most conspicuous of these. This was found in detached pieces, connected with quartz, in the vicinity of Foxdale mine; but the attempts which were made to trace it to its source in the hill, did not succeed. The specimens still preserved, are of considerable magnitude.

It is asserted that manganese has also been found, but I was unable to procure any specimens. I have no reason however to doubt the truth of the assertion.

Hepatic iron ore occurs in Laxey mine, at Spanish

head, and in other places, in small quantities; and being sometimes minutely crystallized, has been mistaken for garnets. Specimens of it were brought to me under this title.

Common clay ironstone is found sparingly among the beds of clay, in the neighbourhood of Castletown and elsewhere; but it is not entitled to any further notice.

Bog iron ore is also to be observed on the surface of the alluvial soil in several places, but, like the former, it requires no further description.

I have already mentioned that a red argillaceous ironstone is seen in the neighbourhood of the sandstone near Peel; and I may add to this, that yellow ochre has been found in sufficient quantity in some of the mineral veins, to have become at one time a matter of export. It is further probable that this ochre was at times mixed with a considerable proportion of decomposed sulphate of copper, since it appears by the mining reports, that copper was obtained in the furnaces from a brown powder which was found in considerable abundance. The mines having long since ceased to be wrought, no specimens of this substance can now be procured so as to permit its true nature to be ascertained.

Such is the list of the detached or independent minerals appertaining to this island, which either fell under my own observation, or concerning which I could procure authentic evidence; and with that list I shall now close this account of the geology of Man.

THE END.

J. MOYES, GREVILLE STREET, LONDON.

ERRATA.

Vol. I.—Page 63, line 25, *insert* A, *before* similar.
88, Note, *instead of* Plate II. *read* Plate XI.
133, line 18, *for* laying, *read* lying.
192, Note, *substitute* Plate XVI. fig. 5, 6.
350, line 2, *after* indeed, *insert* are.
545, —— 22, *for* too, *read* two.
549, —— 11, *for* shortly, *read* easily.

Vol. II.—Page 24, Note, line 5 from the bottom, *for* observe, *read* obscure.
40, line 21, *for* habits, *read* custom.
41, —— 10, *for* has, *read* have.
47, —— 33, *for* for, *read* or.
72, —— 13, *for* renders, *read* render.
83, —— 3 from the bottom, *insert* the *before* Whiten head.
103, line 20, *dele* ?
128, —— 4 from the bottom, *dele* slate.
162, —— 4, *dele* so.
268, —— 19, *for* approximates, *read* appropriates.
285, —— 22, *for* occupy, *read* occupies.
356, —— 4, *for* do, *read* does.
389, last line, *for* series, *read* strata.
390, line 4 from the bottom, *for* pervious, *read* previous.
392, —— 4, *for* character, *read* characters.
451, —— 9 from the bottom, *for* intricate, *read* difficult.

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